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TECHNICAL PAPERS

RESEARCH AND STANDARDS IN ACTION

DEPARTMENTS

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Ten-Part 1958 Book of Standards

Production of the 1958 Book of ASTM Standards is well under way! What is probably the Society's most important publication will begin coming off the production line in October when Part 2, Non-Ferrous Metals, becomes available, to be followed closely by Parts 9 and 4. To expedite publication of Part 1, for which there is the greatest demand, photooffset methods of printing are being used. This method of production will make the volumes available in late November or December. By March of 1959 all ten parts will have been printed, according to the present printing schedule.

The Book of Standards is unquestionably the Society's biggest publication venture. The Book and what it represents is one of the main reasons for the Society's existence. Distributed throughout the world, ASTM standards are used to cover the production, purchase, and evaluation of millions of dollars' worth of materials annually. The size of the Book has increased steadily and rapidly and will continue to grow because, as the Society's technical committee work increases, many more specifications and tests will be issued. The increase from 7 to 10 parts was necessitated by a growth of the size of individual parts to the point where they could no longer be bound economically and were becoming unwieldy in size. It is hoped that the 10-part division will suffice for at least two or three editions.

Supplements to each of the ten parts of the Book of Standards will be issued in 1959 and 1960, with another complete edition scheduled for 1961. The last complete edition of the Book of Standards was published in 1955, with supplements issued in 1956 and 1957. The 1958 edition supercedes these earlier publications and gives all of the standards in their latest form, in conjunction with ASTM Methods of Chemical Analysis of Metals, last published in 1956, which is considered a part of the Book of Standards even though it has no part number because of its separate printing schedule.

Statistics on the 1958 ASTM Book of Standards

10 Parts
2450 Standards
13,600 pages
Total number of copies, all parts—166,000
12 Carloads or 400,000 lb of 30-lb Bible paper
4150 hours of high-speed press time, equal to 520 8-hour days, 103 weeks or 1.98 years for 1 high-speed press
Sewing and binding requires 750 miles of thread, 58,800 lb binders board, 19,250 yd cloth for covers, 6970 lb lining for covers and 2,490,000 sq in. (0.4 acre) gold leaf

Details of Production

As this article is written, much editorial work has been completed by the Staff, and the printer has been working on makeup at the rate of over 100 pages per day since the Annual Meeting. This rate was stepped up beginning the first of September, and will continue at a high rate until January.

On August 18, press work began on the Book of Standards at the rate of 70 press hours per week. This too has since been stepped up to 180 hours per week and will continue through February when it is estimated that press work will be completed. Folding, gathering, binding, boxing, and mailing add to the time required to get the book into the users' hands.

Committee-Staff Teamwork

Publishing and printing activities are complicated, indeed, and there are many interferences that can occur. The Staff and the printer have tried to foresee and take steps to avoid as many of these as possible. Committee personnel responsible for reviewing proofs can help immeasurably to avoid production delays by checking and returning promptly items sent to them for approval or clearance. Any delay can interfere with work on the volume concerned.

Each member may request any one part on his membership and can obtain the other parts and supplements thereto on a subscription basis by payment of $3.00 per part each year in addition to his dues. To date, all but 700 members have returned their instructions for the part or parts they wish to receive. These tardy members are urged to send in their instructions immediately so that the Society may send them their parts as they become available.

1958 Book of ASTM Standards Part Number and Content	Approximate Number of Pages	Approximate Number of Standards	List Price	Member* Price
1 Ferrous Metals (Specifications)	1560	290	$12.00	$10.00
2 Non-Ferrous Metals (Specifications), Electronic Materials	1380	251	10.00	8.00
3 Methods of Testing Metals (Except Chemical Analysis)	980	119	10.00	8.00
4 Cement, Concrete, Mortars, Road Materials, Waterproofing, Soils	1476	338	12.00	9.50
5 Masonry Products, Ceramics, Thermal Insulation, Acoustical Materials, Sandwich and Building Constructions, Fire Tests	1176	226	12.00	9.50
6 Wood, Paper, Adhesives, Shipping Containers, Cellulose, Leather	1152	210	10.00	8.00
7 Petroleum Products, Lubricants, Tank Measurements, Engine Tests	1420	227	12.00	10.00
8 Paint, Naval Stores, Aromatic Hydrocarbons, Coal and Coke, Gaseous Fuels, Engine Antifreezes	1424	353	12.00	9.50
9 Plastics, Electrical Insulation, Rubber, Carbon Black	1612	290	14.00	11.00
10 Textiles, Soap, Water, Atmospheric Analysis, Wax Polishes	1532	267	12.00	9.50
Total			$116.00	$93.00

* In addition to the one part free on membership, members may obtain other parts with supplement thereto, at $3.00 per part per year. The "Member Prices" indicated are for copies members may wish to purchase in addition to those they receive free on their membership or on the $3.00 annual charge.

Actions on Standards

The Administrative Committee on Standards is empowered to pass on proposed new tentatives and revisions of existing tentatives, and tentative revisions of standards offered between Annual Meetings of the Society. On the dates indicated below the Standards Committee took these actions:

Non-Ferrous Metals and Alloys

Tentative Specification for Nickel-Molybdenum and Nickel-Molybdenum-Chromium Alloy Castings (B 332 – 58 T) (Accepted July 25, 1958)

New Tentative.—This specification covers corrosion-resistant nickel-molybdenum alloy and corrosion- and heat-resistant nickel-molybdenum-chromium alloy in the form of sand, centrifugal, and investment castings. The ASME Boiler and Pressure Vessel Committee and the ASA Chemical Industry Advisory Board had requested this specification as well as the other new specifications listed below in the non-ferrous metals field.

Tentative Specification for Nickel-Molybdenum Alloy Plate and Sheet (B 333 – 58 T) (Accepted July 25, 1958)

New Tentative.—This specification covers corrosion-resistant nickel-molybdenum alloy plate and sheet in the hot-rolled, annealed, and descaled condition.

Tentative Specification for Nickel-Molybdenum-Chromium Alloy Plate and Sheet (B 334 – 58 T) (Accepted July 25, 1958)

New Tentative.—There is covered by this specification corrosion- and heat-resistant nickel-molybdenum-chromium alloy plate and sheet in the hot-rolled, annealed, and descaled condition.

Tentative Specification for Nickel-Molybdenum Alloy Rod (B 335 – 58 T) (Accepted July 25, 1958)

Tentative Specification for Nickel-Molybdenum-Chromium Alloy Rod (B 336 – 58 T) (Accepted July 25, 1958)

New Tentatives.—Specification B 335 covers corrosion-resistant nickel-molybdenum rod, and Specification B 336 covers corrosion- and heat-resistant nickel-molybdenum-chromium alloy under two conditions: Hot-Finished, Annealed, and Descaled, $^5/_{16}$ to $^3/_4$ in., excl., in diameter, and Hot-Finished, Annealed, and Ground or Turned, $^3/_4$ to $3^1/_2$ in., incl., in diameter.

Tentative Specification for Nickel-Copper Alloy Plate, Sheet, and Strip (B 127 – 49 T) (Accepted July 25, 1958

Tentative Specification for Nickel Rod and Bar (B 160 – 49 T) (Accepted July 25, 1958)

Tentative Specification for Nickel Seamless Pipe and Tube (B 161 – 49 T) (Accepted July 25, 1958)

Tentative Specification for Nickel Plate, Sheet, and Strip (B 162 – 49 T) (Accepted July 25, 1958)

Tentative Specification for Seamless Nickel Alloy Condenser and Heat Exchanger Tubes (B 163 – 49 T) (Accepted July 25, 1958)

Tentative Specification for Nickel-Copper Alloy Rod and Bar (B 164 – 49 T) (Accepted July 25, 1958)

Tentative Specification for Nickel-Copper Alloy Seamless Pipe and Tube (B 165 – 49 T) (Accepted July 25, 1958)

Tentative Specification for Nickel-Chromium-Iron Alloy Rod and Bar (B 166 – 49 T) (Accepted July 25, 1958)

Tentative Specification for Nickel-Chromium-Iron Alloy Seamless Pipe and Tube (B 167 – 49 T) (Accepted July 25, 1958)

Tentative Specification for Nickel-Chromium-Iron Alloy Plate, Sheet, and Strip (B 168 – 49 T) (Accepted July 25, 1958)

Revision.—Manufacturing practices have undergone a series of changes since 1949 and these specifications have been revised to reflect present practices.

Paint, Varnish, Lacquer and Related Products

Tentative Method of Test for Acetone in Methanol (Methyl Alcohol) (D 1612 – 58 T) (Accepted July 24, 1958)

New Tentative.—This method describes a procedure for detecting the presence of acetone in methanol in amounts greater than 0.003 per cent by weight. The sample is reacted with Nessler's Reagent and the turbidity which is produced is compared to a standard containing the equivalent of 0.003 per cent by weight acetone. It provides a procedure to be used in the Standard Specifications for Methanol (D 1152)

Tentative Method of Test for Acidity in Lacquer Solvents and Diluents (D 1613 – 58 T) (Accepted July 24, 1958)

New Tentative.—This method describes a procedure for determining total acidity as acetic acid in concentrations below 0.05 per cent in organic compounds and hydrocarbon mixtures used in paint, varnish, and lacquer solvents and diluents. It is known to be applicable to such mixtures as low molecular weight saturated and unsaturated alcohols, ketones, ethers, esters, hydrocarbon diluents, naphtha, and other light distillate petroleum fractions. The method had been issued previously as Section 10 on Acidity of the Standard Methods of Sampling and Testing Lacquer Solvents and Diluents (D 268 – 53).

Tentative Method of Test for Alkalinity in Acetone (D 1614 – 58 T) (Accepted July 24, 1958)

New Tentative.—This method had been published previously as Section 11(*b*) on Alkalinity of Acetone of the Standard Methods of Sampling and Testing Lacquer Solvents and Diluents (D 268 – 53). The sample is added to distilled water previously neutralized to the methyl red end point. If alkalinity is detected, it is titrated with 0.05 *N* sulfuric acid and reported as per cent by weight NH_3.

Tentative Method of Test for Glycerol, Ethylene Glycol, and Pentaerythritol in Alkyd Resins (D 1615 – 58 T) (Accepted July 24, 1958)

New Tentative.—Procedures are provided for the determination of the three most common polyhydric alcohols used in the manufacture of alkyd resins and resin solutions in the absence of certain stated interfering materials. The method will be useful in conjunction with Standard Method of Test for Phthalic Anhydride Content of Alkyd Resins and Resin Solutions (D 563 – 52) and Tentative Method of Test for Fatty Acid Content of Alkyd Resins and Resin Solutions (D 1398 – 56 T) which provide procedures for determining two other major constituents of alkyd resins.

Tentative Method of Test for Copper Corrosion by Mineral Spirits (Copper Strip Test) (D 161 – 58 T) (Accepted July 24, 1958)

New Tentative.—The method describes in detail the procedure for blackening now summarized in Standard Specifications for Petroleum Spirits (Mineral Spirits) (D 235 – 39), and Tentative Specifications for Heavy Petroleum Spirits (Heavy Mineral Spirits) (D 965 – 48 T). It parallels five other similar ASTM methods for other solvents and petroleum products, and uses the ASTM Copper Strip Corrosion Standards as reference standards.

Tentative Method of Test for Unsaponifiable Matter in Alkyd Resins and Resin Solutions (D 1397 – 56 T) (Accepted July 24, 1958)

Revision.—The revision provides for the detection and determination of the amount of fatty acids which may be included with the recovered unsaponifiable matter and subsequent correction of the results, thereby improving the accuracy of the method, particularly when it is applied to materials having relatively low percentage of true unsaponifiable.

Electrical Insulating Materials

Standard Specification for Black Bias-Cut Varnished Cloth and Varnished Cloth Tape Used for Electrical Insulation (D 373 – 55) (Accepted July 14, 1958)

Revision and Reversion to Tentative.—The specification has been revised generally in order to correct numerous shortcomings.

Mass Spectrometry

Tentative Recommended Practice for Evaluation of Suitability of Mass Spectrometers for Use in Methods of Chemical Analysis (E 137 – 58 T) (Accepted July 24, 1958)

New Tentative.—This recommended practice is intended to provide general criteria for judging the suitability of a mass spectrometer for use in ASTM mass spectrometric methods of chemical analysis. Also included are discussions of generally useful tests that are helpful in judging the performance of a particular mass spectrometer for a particular ASTM method of analysis.

INSTRUMENTATION —*Where We Stand*

By ALLEN V. ASTIN

Instrumentation for the measurement of high temperature, high pressure, direct force, and microwave quantities presents a crucial challenge in a most important world-wide technological competition; industry must join government in winning this competition, according to Dr. A. V. Astin, director of the National Bureau of Standards, at the Instrument and Apparatus Luncheon of the 1958 ASTM Annual Meeting.

I APPRECIATE this opportunity to talk about instrumentation at a meeting of the ASTM. This opportunity is especially exploitable because we who represent the National Bureau of Standards, and you, who represent the instrument industry, should seek to exchange opinions and data concerning the continuing technical needs of the instrument sciences. We should seize on these occasions to review our situations and to make a fair appraisal of requirements and shortcomings. It is especially appropriate that such an appraisal be attempted during this meeting of the ASTM. **No area of science and technology is more critically affected by instrumentation or the lack of it than that of materials development and evaluation.** An important part of the emphasis which has been given this week to material research frontiers has been devoted to associated instrumentation problems.

Here in the middle of 1958, there can be no doubt that technology lies at the center of human activity. It touches upon the dramatic in space exploration. It is a dynamic force in international relations. It has a vital effect upon our national economy. And it has a subtle yet definite relationship to every material substance and device which each of us, as individuals, uses in achieving our high standard of living. All this we can attribute in some direct or indirect way to science. In a direct way we can establish a relationship between progress and the measurement sciences. The most tangible form of measurement progress is instrumentation. The whole of technology depends upon our ability to apply science and measurement through instrumentation.

The importance of instrumentation to technical progress can hardly be overemphasized. Instrumentation is a scientific specialty of significant technical stature in its own rights. Its recognition as a special area of research and development does not stem entirely from the increasing numbers and uses of scientific instruments available for laboratory study or for production-line testing and measurement. Instrumentation plays a unifying role in all of the sciences. Instrumentation is more than just a totality of measuring instruments. It involves systems and methods of use, the theory of response characteristics of physical

(*Continued on next page*)

ALLEN V. ASTIN, director of the National Bureau of Standards, is a member of twenty-one important policy-making committees ranging from the National Advisory Committee for Aeronautics to the governing board of the American Institute of Physics. A physicist, he received his A.B., in 1925 from the University of Utah, and his M.S., in 1926, and Ph.D., in 1928, from New York University where he was a teaching Fellow. After spending two years as a National Research Fellow at The Johns Hopkins University, he joined the National Bureau of Standards in 1930. From 1932 to 1940, when he joined the proximity fuse project, he did research in the Heat and Power Division. His principal research has been in measurement techniques related to electrical insulation, resulting in both improved instrumentation and a better understanding of the nature of energy losses in air capacitors. He did pioneering work in the development of radio telemetering techniques and instruments, work which he has applied to studies of the earth's atmosphere and cosmic rays. He played a major part in the development and evaluation of proximity fuses. Dr. Astin became chief of the Electronics Division in 1948 and director of the entire Bureau in 1952.

systems, the theoretical and practical aspects of the generation and handling of signals, the concept of feedback, automatic control, and other functions. In general terms, **we at the National Bureau of Standards consider instrumentation as the science and art of providing devices and techniques for physical measurement and observation and for processing the results thereof.** Instrumentation partakes of that special quality of science and research which can be characterized as regenerative. On the one hand instruments providing refined measurement may open new areas of scientific exploration and, on the other, these new areas may lead to new and improved measuring devices. It should be made evident that the terms "device" and "instrument" are not inclusive of the entire meaning of instrumentation. They merely name the tangible end items of the science. The underlying import of instrumentation is that we are dealing with the common denominator of all experimental science, that of measurement. Instrumentation is the means by which scientists and engineers are able to take the agreed-upon units provided by physical standards and make them uniformly operational in laboratory science and in production-line applications.

Aside from these philosophical generalizations about instrumentation, there is direct evidence of the central role which instruments and systems of instruments play in modern science and technology. Wherever we look at the Nation's research and development effort, we note an intensive effort to devise, compact, and package precision instruments for the observation and measurement of physical phenomena. You must be aware, I am sure, of the intricate role which instrumentation is playing in the satellite and space exploration programs. It was with considerable interest that we learned that the newly launched Soviet Sputnik was a significant achievement in instrumentation. We are told that this satellite is a virtual space laboratory full of quality-designed instruments to provide for optimal observation and measurement while it travels its orbital destiny.

Instruments Essential to ASTM Work

Yet I do not want to associate instrumentation primarily with such spectacular aspects of science. Instruments are now used in every single phase of measurement and experimental determination. It is for this reason that it is so vital to the members of the Society for Testing Materials. In studying the properties of materials, in determining physical characteristics, in testing conformance to specification, and in observing behavior under various conditions, instruments have their essential role. In industry, where new products are being developed and new materials are required to serve specialized purposes, instruments are the basic research tools used in industrial laboratories. In production, precision control and recording instruments have become major assets in achieving improved production of highly-uniform goods.

The great attention which has been focused upon automation in recent years is primarily due to the opportunities which have been opened by developments in instrumentation. In spite of popular impressions, automation is an old concept. But it does have new and extensive areas of application primarily because of revolutionary advances in such instrumentation specialties as automatic computation and servomechanical systems.

Computers Speed Decision Process

To cap this recognition of the complex but essential role of instrumentation in modern times, I would like to return to the area of national defense for my final illustration. In the last decade, instrumentation has caused a veritable revolution in defense thinking. Pushbutton warfare is now no longer as fantastic as it once seemed. The other day I was reading of a computer which was already programmed to issue a highly-complexly-integrated set of defense instructions with split-second decision based upon a large number of data sources or inputs. The item emphasized the point that the computer was able to do this in a small fraction of the time that it would take a general and his staff to come to a similar or lesser decision. The notion of using equipment to observe, record, transmit, and analyze situations is no longer scientific fiction. I believe that all this is made possible because of advances in the field of instrumentation. No major weapon of a modern arsenal of defense makes sense which does not take advantage of these advances. In similar way, one ought to be able to say that no device in our peacetime economy should make sense if it does not take full advantage of possibilities for improvement offered by an advancing science of instrumentation.

Major changes have already been wrought in our economy. In a technological sense, American industry is very different from what it was a quarter of a century or even a decade ago. I believe that the field of instrumentation can take major responsibility for this technological change. The Instrument Society of America was established only 13 years ago. It now has about 10,000 members and is one of our most rapidly growing professional organizations.

A review of data issued by the Department of Commerce's Office of Area Development on the growth of the instrument industry in the United States shows substantial expansion patterns. Using 1947 as a base year, one finds that by 1954 America's scientific instruments industry was shipping 395 per cent more manufactured products than it did in the base year. In the field of optical instruments and lenses, the increase was 159 per cent over the base. In certain selected subcategories, such as aircraft flight instruments, there had been an increase of more than 1750 per cent. I have no accumulated data beyond the year 1954, but I feel reasonably certain that there has been continued expansion in the area of instrumentation, especially since more and more areas of technology find it necessary, on a competitive level, to incorporate the latest devices and instruments into production and development processes.

Instruments Explore New Areas

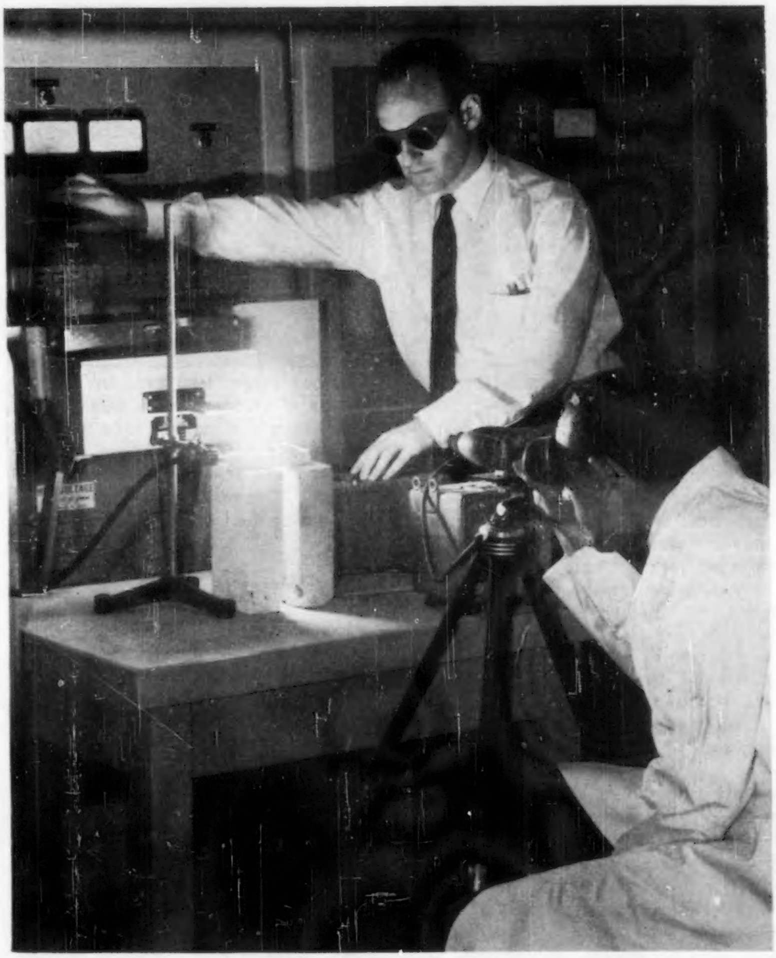
Despite this almost phenomenal growth in the instrument industries, there seems to remain an excellent opportunity for further expansion, especially into those areas which have not benefited from new measurement devices. In some cases, economic and industrial expansion of the instrument sciences must await initial and important instrument research. This is actively the case in a number of important fields of current research and development. The sequence of industrial instrument expansion into new fields seems as follows: first, to provide the instruments for exploration of a new scientific area; second, to provide the instruments for introducing this new area into our technology; and finally, to provide the instruments for exploitation of the new technology. Because this country is by its nature one which requires continual expansion, because we are now faced by serious economic and military challenges from abroad, and because there are a number of new scientific areas of intense research interest, we cannot afford to become complacent. Although we can look back with considerable satisfaction at the growth of the instrument industries, we must take every opportunity to accelerate our efforts for further progress. Only in this way can we assure the fuller technical strength required by the nation in the tough internationally competitive years ahead.

Problem Areas

I shall have more to say about this international competition shortly, but before that I want to describe some technical areas where research instrumentation has a major role to play. These are selected areas where there exist major unsolved problems. They are examples from the experience of the National Bureau of Standards. We, at the Bureau, are in a rather unique and opportune position to be aware of the nation's measurement and instrumentation shortcomings. We are faced with a continuous demand for measurement and calibration services which we cannot perform. In fact, recently we made a survey of requests for services which the Bureau was in no position to satisfy. It is occasionally somewhat shocking to realize the number of measurement and calibration areas where our own technical proficiency is inadequate.

High Temperature

One of the areas of critical scientific need is that of high temperature. We are lacking in standards, instruments, measurement techniques, and materials data which better instruments would make possible. The past decade has seen great advances in high-speed flight, highly-energetic propulsion systems, guided and ballistic missile development, jet engines, atomic reactors and power plants, and a major industrial shift to high-temperature production and products. All have brought overwhelming requirements for new basic data, new heat-resistant materials, and new types of instruments and measurement techniques which can operate at temperatures far in excess of 1000 C. The need is so great, in fact, that technological progress must remain at a standstill, so to speak, until these measurement and instrumentation problems are resolved. The lack of measurement techniques and devices is proving to be one of the severest deterrents to laboratory and field experiments. The lack of measurement devices, techniques, and basic standards sternly limits the meaningful exchange of significant research information among laboratories in the high temperature field. Knowledge of the behavior of materials at high temperatures is urgently needed. In the push for high-temperature operations, the need is for data which do not exist today. Above 1000 C very little usable data are available. At 2000 and 3000 C there is a more serious lack. Beyond that there is almost a complete void. Lower temperature information is of very limited use in these cases because relatively few properties can be extrapolated with any reliability. One cannot predict high temperature behavior and properties of materials on the basis of experience at normal temperatures. At high temperatures, impurities may have a pronounced unpredictable effect.



Observing the melting behavior of a ceramic at the National Bureau of Standards. Sample, visible through a small hole, is observed with optical pyrometer.

The situation is especially grave when considered in the light of Russia's measurement achievements in this field as described in their official journal of measurement engineering. Their national standardizing organization has claimed an ability to make regular calibration of temperature measuring devices up to 6000 C and their scientific plans call for increasing this calibration competence so that by 1960 they will provide this calibration service up to 12,000 C. At the National Bureau of Standards, our regular practice in making direct high-temperature calibrations extends to 2800 C which we usually certify to an accuracy of 8 deg Cent. On a very limited basis we are able to extrapolate our high-temperature calibrations to 4000 C, but with some sacrifice of accuracy. We believe we may on a very very limited indirect basis calibrate to 6000 C but with what sacrifice of accuracy it would be difficult to state at this time. The point is that we provide regular calibrations only to 2800 C. Beyond that, our service is severely restricted by lack of controlled high-temperature sources. We are presently dependent upon impromptu methods. I might add a footnote here. We did describe this situation to the Congress during our appropriation hearings last May. The Congress recognized the seriousness of the situation and earmarked funds to begin overcoming this serious lack. To answer the challenge fully, however, will require an effort beyond that which the Bureau can muster at this time. It is especially important that instrument and scientific apparatus manufacturers help to provide the devices necessary to mount a full-scale

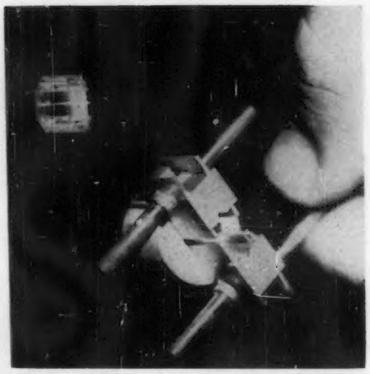
attack upon the problem. This is especially important because the Russian interest and competence in making measurements at these high temperatures is indicative of a very substantial effort in this very critical technological frontier.

High Pressure

Another area where there are major unsolved instrumentation and measurement problems is that of high-pressure research. During the past year the National Bureau of Standards has been indeed fortunate in having the services of Dr. Leason H. Adams who served so effectively as director of the Geophysical Laboratory of the Carnegie Institution of Washington. Dr. Adams was requested to make a critical survey of needs in this scientific and technological area. In his report to the Bureau, he recognizes the rapid spread of high-pressure research in this country and the increasing industrial use of high pressure research in this country and the increasing industrial use of high pressures in product synthesis. It is entirely likely, Dr. Adams states, that super-pressure will ultimately yield additional new forms of matter of scientific and industrial interest. The transitions that take place only at high pressures represent an exciting field for serious attention. Here then is a situation very like that of high temperature. We are at the brink of new scientific development, and ultimately this will lead to industrial application and new products. Again the obstacles to efficient progress are those of physical standards, techniques of measurement, and instrumentation. These are urgently needed at the research stage in advance of the development of engineering data on the properties of materials at these new pressures. Despite improvements in pressure-measuring and pressure-producing devices, there is a need for specific attention to high-pressure instrumentation with respect to both mechanical and electrical features. At the Bureau, we appreciate very much the road charted for us by Dr. Adams and, during the next five years, we hope to intensify our work in this area. It is a critical one and, I believe, it deserves further attention from the instrument sciences.

Direct Force

Another technical area where there exist major unsolved instrumentation problems is that of direct force measurement. We have, in the past five years, entered upon an era of developing thrusts for propulsion far in excess of anything contemplated previously. We can predict required thrusts above that of a million pounds as a routine part of newer propulsion systems. We are



Diamond (upper left) used by National Bureau of Standards as a high-pressure cell. Sample of material to be studied is placed in a narrow hole bored through diamond and compressed between steel pistons. Changes in sample are detected by studying the way it transmits infrared light.

already aware that the recent 2900-lb Sputnik launched by the Russians probably achieved a thrust of several hundred thousand pounds, perhaps as high as a half million pounds. We have also read of facilities being built which will provide for the study of liquid propellants developing a thrust of up to two million pounds. We can expect that military requirements will continue to call for initial power developments far beyond what we can now measure with any degree of the required accuracy. I am sure that you realize the importance of developing accurately controlled thrust in ballistic flight. The initial stage of such flight depends almost entirely upon this element, and, needless to say, the entire flight is dependent upon this first stage. The devices used to develop such controlled thrust are dependent upon effective calibration services. There is now a demand for calibrations which will provide a certification of a 1,000,000-lb device to 0.1 per cent. Such calibration accuracies cannot be provided at present. This is truly a serious situation for it may result in severe engineering delays in important development programs. To help meet this situation, the Bureau is developing plans for extending its calibration services for force measuring devices as well as seeking to activate plans for providing direct measurement of load-cell systems and other devices up to a million pounds. The provision of such direct calibrations, of course, must await considerable expansion of the Bureau's present dead-weight capabilities. In the meantime, the Bureau will assist all force-measuring instrument organizations with technical advice and related calibrations in order to serve the present and growing need.

Microwave Frequencies

Still another area where major unresolved instrumentation problems exist is that of electronic measurement devices for use at ultra-high and microwave frequencies. Again we have arrived at the edge of new developments only to find ourselves held back by inadequate measurement standards, techniques, and instrumentation. About two years ago, the Boulder Laboratories of the National Bureau of Standards conducted a survey of the electronics industry in order to gage the extent of need for calibration services and standards. The need was so extensive that the Bureau will place strong emphasis for several years to come upon the development of new and improved radio standards. This intensified effort will help to fulfill the resolution passed last August by the 12th General Assembly of the International Scientific Radio Union recommending an intensified national effort in the standardization programs of high-frequency and microwave quantities such as power, impedance, voltage, current attenuation, field strength, and noise. It should be recognized that a number of current research and development programs as well as operating activities are suffering because of the inability of the Bureau to meet adequately this existing need. Just about one month from today, the new electronics calibration center will be dedicated at the Bureau's Boulder Laboratories. This center will have as its major purpose the provision of calibration services to military organizations and to the electronics industry. In addition, the Radio Standards Division of the Boulder Laboratories has embarked upon an earnest program to overcome the lack of much-needed radio standards. The electronics instrument manufacturers, of course, have an important stake in these accelerated programs. It is important, therefore, that the services which are required of the Bureau be made known to us on a continuing basis. It is equally vital that the instrumentation industry undertake additional research and development in this vital area.

General Problems

There are, of course, many other technological areas which deserve the attention of the instrument sciences. There are also some general problem areas of which it might be worth while to mention three briefly. The first of these is that of "reliability." I am sure that you all realize that as operating instrumentation systems become more complex and as these systems become an intricate maze of interde-

pendent components the problem of estimating systems life-expectancy and system-reliability become extremely difficult. This is a special problem, for the performance of any one component becomes in a sense a function of almost every other component. If we do not develop a rational basis for evaluating this interdependency, we may be restricting the whole future of instrumentation.

A brief mention must also be made of the problem of miniaturization. This area is of great significance to progress in aeronautics and space science. We recognize the need for size reduction in instruments and instrument systems, but it is essential that we achieve such reductions without any significant sacrifice in operating efficiencies. Here again a rational basis for this fast-growing segment of instrumentation is necessary. I believe that this rational basis now exists in the essential coupling of manufacture and precision measurement, not merely measurement of dimensional characteristics but of all physical characteristics, including the purity of basic materials used in miniaturized devices. Advances in miniaturization require extremely high instrumentation competence, and the application of this competence to the development of more and better instruments or other devices has a far-reaching effect both on the rate of scientific progress and the application of scientific knowledge to our material welfare.

Education Needs More Emphasis

One more area which deserves more emphasis than I can give it here is that of training and educating scientists for instrumentation. While instruments and measuring devices have a general applicability to all of science and technology, scientists in other fields look upon these merely as tools. It is essential that instrumentation specialists be trained and developed who will seek progress in this field for its own sake and thereby will form the corps of technical experts who can provide a multiple service to the other sciences. Such a corps of specialists will provide for efficient technical advice as well as for research and development in this area, thus contributing considerably to the effective utilization of our short supply of scientists and engineers. In this connection, may I call attention to the valuable work being undertaken by the Foundation for Instrumentation Education and Research which is now in its second year of activity. The goals of this organization are such that they deserve attention and support. I am especially concerned that members of the instrument-making industry join in some of these important educational programs.

Technological Competition is World-Wide

I mentioned earlier that the United States was engaged in a most important international technological competition. The competition is of major importance to the instrumentation industry for it concerns instrumentation and measurement directly. As part of a major five-year effort to increase national productivity and to challenge America's economic supremacy, the Soviet Union has been involved in a concerted effort to increase its measurement competence and to bring this competence to bear, as quickly and as directly as possible, u[illegible] instrument manufacture and finall, upon production line and factory use. Their plans seem to be well considered and their programs are directly toward significant measurement and operational goals. There can be little doubt, if we are to take their own statements seriously, that the Russians are investing considerable technical effort in these areas. It is especially significant that they are directing their efforts toward application of these programs to the machine production industry, to extensive expansion of their instrumentation industry, and to acceleration of programs for automation.

One thing is certain from Russia's own description of its program: it fully understands the essential role of measurement and instrumentation in technological development of the nation. The organization of measurement in government and industry is rigidly but, at least so it seems, rationally administered and supported. Under its Committee on Standards, Measures, and Measurement Apparatus, which has high government ranking, are five major research institutes devoted to research and development in the measurement and instrumentation sciences. Below this research level are more than 100 calibration centers geographically distributed to provide calibration services to industry, to enforce precision standards, and to bring the activities of the research institutes directly to bear upon industry. The chain of measurement is thus linked strongly, at least on paper, from research laboratory to production line. It is also apparent that the Russians are concerned with precision in an operational sense. It is the purpose of their system to bring precision to use only to the degree that it is required. They are aware of the wastefulness of extreme tolerances where lesser accuracy would be equally serviceable. The Russians, through a systematic method of classification and application of varying degrees of precision in their instruments and their use, coupled with thorough education and training, seem to understand the problem fully.

Dr. Astin observes the calibration of a 250,000 pound force measuring system of the type used for measuring the thrust of rocket motors.

I don't think that it is necessary to emphasize to this audience the seriousness of this challenge. More than any other group, you can realize the effect of such a concerted program upon a nation's technological future. In this country, we have no such rigid system of enforcing precision. We rely upon cooperative recognition of important programs and upon mutually self-generated programs to serve our needs and that of our country. A large part of meeting this crucial challenge must be borne by the National Bureau of Standards in stepping up its standards research and measurement programs. But an even larger responsibility rests with the instrumentation industry in strengthening its measurement research and development programs and in bringing and extending precision to American factories and production lines. In this important area, industry must join government in winning the competition.

ASTM Bulletin

SEPTEMBER 1958

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NINETEEN-SIXTEEN
RACE STREET
PHILADELPHIA 3, PENNA.

Progress Through Long Range Planning

VERY few companies, or for that matter, associations or technical societies can expect to make continuing progress unless there is what we sometimes term a "forward look." This may be achieved through a committee or group which usually is instructed to do some long-range planning.

While in ASTM most of the technical committees, the Directors, and the Staff constantly try to be alert for future obligations and how to discharge these, until recently, no special group was charged with the specific task of taking an over-all look at the Society, its functions and operations. A somewhat similar "Study Committee," devoted several meetings to a review of ASTM, this group having reported in 1946.

As mentioned in the 1958 Report of Directors, a Long-Range Planning Committee (LRP) has been appointed and has been functioning for the past year under the chairmanship of R. C. Alden, former national Director, and for many years chairman, Research Planning Board, Phillips Petroleum Co. Associated with him are top officers of the Society, including several past-presidents. The committee has held several meetings and the work is now getting into "high gear."

To highlight areas to be reviewed, some 60 fundamental questions have been set down, and groups of these are being referred to Study Groups.

The field of education was one which LRP felt should and could be considered promptly. As a result of recommendations to the Board, two new committees are being established—(1) a new Administrative Committee on Education in Materials which will report directly to the Board and (2) a second committee which will develop a program and administer a Doctorate Fellowship aggregating $6500 annually and five annual Grants-in-Aid of $1000 each.

The Administrative Committee on Education includes able representatives from engineering schools and industry. The Board is pleased to announce the chairman will be Glenn Murphy, head, Department of Theoretical and Applied Mechanics, Iowa State College. Dr. Murphy holds the Chair as Anson Marston Distinguished Professor of Engineering at Iowa State and is also vice-president, American Society for Engineering Education.

The Committee on Fellowships and Grants-in-Aid again including representatives from schools and industry broadly, will be headed by A. T. Mavis, Dean of Engineering, University of Maryland, a long-time member of the Society.

Standards and Technical Committees

The Society, from the very nature of its activities, has many complicated areas of work. There are two which seem of utmost importance to LRP, namely, the work in **standardization,** and also **technical committee operations and activities.** Two study committees are being appointed in these areas: the one on Standardization Procedures will be headed by an honorary member of the Society, Albert T. Goldbeck, long-time engineering director, now retired, National Crushed Stone Assn.; with the Committee on Technical Committee Activities being chaired by R. W. Seniff, director of research, Baltimore & Ohio Railroad Co., currently a national director. Serving with each of these men will be some 12 to 15 very active ASTM members with broad experience, not only in our operations, but also with wide knowledge and activity in the work of other organizations.

Long-range planning involves studies of membership, research phases of the Society's work—so fundamental and basic to standardization—its publication activities—because in most instances the end point of a technical activity is a significant publication—and others. In all of these studies the projection period is ten years.

The Board of Directors and the Long-Range Planning Committee are confident that as a result of these various studies and coordination of recommendations the Society can be in a good position to handle its rapidly growing responsibilities in research and standards for materials. From time to time further information will be given of the studies under way, and the personnel for the LRP study committees will be announced.

Should any member of the Society or member of a technical committee have suggestions which he feels are pertinent to long-range planning, the officers will be glad to have these.

Meanwhile, the intensive activities of ASTM proceed apace. For example, 1958 is the year when the ten-part, Book of Standards will be issued. The presses are now running full tilt on this 14,000-page publication. Eventually some 166,000 separate books will be issued in this project.

Offers of Papers for 1959 Meetings

Annual Meeting, June 21–26, Atlantic City, N. J.
Third Pacific Area National Meeting, October 11–16, San Francisco, Calif.

THE Administrative Committee on Papers and Publications will meet early in 1959 to consider the papers to be published by the Society in 1959 and to develop the program for the Annual Meeting in June and the Third Pacific Area National Meeting in October.

All those who wish to offer papers for presentation at these meetings and for publication by the Society should send these offers to headquarters not later than January 1 for the Pacific Coast papers and January 10 for the Annual Meeting papers.

All offers should be accompanied by a summary which will make clear the intended scope of the paper and which will indicate features of the work that will, in the author's opinion, justify its publication and inclusion in the programs of the Annual Meeting or Pacific Area National Meeting.

Suitable forms for use in transmitting this information will be sent promptly upon request to headquarters.

Symposium on Cleaning of Electronic-Device Components and Materials

CURRENT progress in the control of contamination during assembly of electronic device components and materials will be discussed in a two-day symposium, at the Franklin Institute in Philadelphia, on October 13 and 14, sponsored by ASTM Committee F-1 on Materials for Electron Tubes and Semiconductor Devices.

With the great current emphasis on reliability of electronic devices, the symposium and the subsequent publication of the proceedings should make important contribution toward general improvements in reliability in electron tubes and semiconductor devices.

The symposium will comprise four sessions to be held in the morning and afternoon of the two days. On Monday evening, October 13, ASTM Committee F-1 will join with the ASTM Philadelphia District in a dinner and social hour. Julian K. Sprague, president, Sprague Electric Co., North Adams, Mass., will speak on the relationship of reliability in components to performance of electronic systems.

The following is the symposium program:

October 13, 1958

Chairman: S. A. Standing, Raytheon Manufacturing Co.

MORNING SESSION—**Physical and Organic Contaminants**
Moderator: H. M. Cleveland.

Measuring and Controlling Dust—P. R. Pondy and G. E. Helmke, Bell Telephone Laboratories.

Planning and Operating a Clean Shop—W. T. Dyall and L. C. Herman, Radio Corporation of America.

An Ultrasonic Washing System for Eliminating Physical Contaminants from Electronics Devices—D. E. Koontz and I. Amron, Bell Telephone Laboratories.

Operation Snow White Approach—K. D. Johnson, General Electric Co.

Detection, Removal, and Control of Organic Contaminants in the Fabrication of Electronic Devices—D. O. Feder and D. E. Koontz, Bell Telephone Laboratories.

Cleanliness Factors in Mechanical Processes and Etching of Semiconductors—J. W. Faust, Jr., Westinghouse Electric Corp.

AFTERNOON SESSION—**Gaseous Contaminants**
Moderator: C. W. Horsting, Radio Corporation of America.

The Design and Use of a Mass Spectrometer to Study Gas Problem in Electron Device Development—E. J. Becker Bell Telephone Laboratories.

Use of the Mass Spectrometer to Evaluate the Effectiveness of Processing Tube Materials—R. W. Griessel, General Electric Co.

Carbon as an Indicator of Gas Content of Metallic Tube Components—D. R. Kerstetter, Sylvania Electric Products, Inc.

The Analysis and Control of Gas Atmospheres Used in Electronic Device Parts Treatment—M. J. Elkind and D. R. Benn, Bell Telephone Laboratories.

The Adsorption and Desorption Characteristics of Graphite Conductive Coatings—J. C. Turnbull, H. A. Stern, and D. J. Donahue, Radio Corporation of America.

Hydrogen Absorption by Tube Parts Due to Various Processing Procedures—D. Lichtman, Sperry Gyroscope Co.

October 14, 1958

Chairman: S. Umbreit, Radio Corporation of America.

MORNING SESSION—**Chemically Combined Contaminants**
Moderator: D. E. Koontz, Bell Telephone Laboratories.

Cathodic Electrocleaning of Molybdenum Wire Prior to Gold Plating—R. W. Etter, Radio Corporation of America.

The Preparation of Ultra Clean Electron Tube Components by Chemical Etching—D. E. Koontz, C. O. Thomas, W. H. Craft, and I. Amron, Bell Telephone Laboratories.

Use of Radiotracers in Parts-Cleaning Evaluation—M. N. Slater and D. J. Donahue, Radio Corporation of America.

The Effect of Parts Cleaning on Tube Performance—J. C. Hickle and S. C. Crawford, General Electric Co.

Thermionic Emission from Oxide Cathodes as Related to Glass Envelope Composition—H. E. Kern and E. T. Graney, Bell Telphone Laboratories.

Ultra-Clean Diode, An Emission Tester for Evaluating Cleaning Processes—R. W. Olthuis, Sperry Gyroscope Co.

AFTERNOON SESSION—**Soluble Contaminants**
Moderator: A. P. Haase, General Electric Co.

The Preparation and Use of High Purity Intrinsic Water for Electron Device Parts Processing—D. E. Koontz and M. V. Sullivan, Bell Telephone Laboratories.

The Preparation of High Purity Methyl Alcohol for Use with Semiconductor Devices—H. F. John, Westinghouse Electric Corp.

The Utilization of Pure Water in Electronic Device Manufacture—P. P. Pritchett, Western Electric Co.

Facilities for the Symposium at the Franklin Institute will limit the attendance to 350. Therefore, attendance will be by application and subsequent invitation. Anyone wishing to apply for attendance at the Symposium may write to F. J. Biondi, Bell Telephone Laboratories, Inc., Murray Hill, N. J. It is especially desirable that all who have an interest in this subject and can contribute to the discussions following the papers make application to attend.

ASTM National Meetings—1959-1963

(Members may wish to clip this for their files)

Year	Committee Week	Annual Meeting	Pacific Area National Meeting
1959	February 2–7 Penn-Sheraton Hotel Pittsburgh, Pa.	June 21–26* Chalfonte-Haddon Hall Atlantic City, N. J.	October 11–16 Sheraton-Palace Hotel San Francisco, Calif. (With Exhibit)
1960	February 1–5 The Sherman Chicago, Ill.	June 26–July 1 Chalfonte-Haddon Hall Atlantic City, N. J. (With Exhibit)	
1961	January 29–February 3 Netherland Hilton Hotel Cincinnati, Ohio	June 25–30 Chalfonte-Haddon Hall Atlantic City, N. J.	
1962	February 5–9 The Statler Hilton Dallas, Tex.	June 24–29 Hotel Statler New York, N. Y. (With Exhibit)	September 30–October 5 Hotel Statler Los Angeles, Calif.
1963	February 3–8 Queen Elizabeth Hotel Montreal, Canada	June 23–28 Chalfonte-Haddon Hall Atlantic City, N. J.	

* Note.—Annual Meeting of American Society for Engineering Education is to be held the preceding week and will not conflict.

Schedule of ASTM Meetings

This gives the latest information available at ASTM Headquarters. Direct mail notices of all district and committee meetings customarily distributed by the officers of the respective groups should be the final source of information on dates and location of meeting. This schedule does not attempt to list all meetings of smaller sections and subgroups.

Date	Group	Place
Oct. 1–2	Committee C-8 on Refractories	Bedford, Pa. (Bedford Springs Hotel)
Oct. 2–3	Committee C-22 on Porcelain Enamel	Annapolis, Md. (Naval Engineering Experiment Station)
Oct. 5–9	Committee D-2 on Petroleum Products and Lubricants	Washington, D. C. (Mayflower Hotel)
Oct. 6	Southeast District	Gainesville, Fla. (Univ. of Florida)
Oct. 8	Southeast District	Atlanta, Ga. (Georgia Tech.)
Oct. 9	Washington, D. C. District	Knoxville, Tenn. (Univ. of Tennessee)
Oct. 10	Ohio Valley District	Lexington, Ky. (Univ. of Kentucky)
Oct. 13	Philadelphia District	Philadelphia, Pa. (McAllisters)
Oct. 13–14	Symposium on Cleaning Electronic-Device Components and Materials	Philadelphia, Pa. (Franklin Inst.)
Oct. 13–15	Committee C-16 on Thermal Insulating Materials	Madison, Wis. (Ivy Inn)
Oct. 14–17	Committee D-13 on Textile Materials	New York City (Sheraton-McAlpin)
Oct. 15	Committee F-2 on Flexible Barrier Materials	Chicago, Ill. (Edgewater Beach Hotel)
Oct. 16–17	Committee C-23 on Sorptive Mineral Materials	Detroit, Mich. (Statler Hotel)
Oct. 16–17	Committee D-10 on Shipping Containers	Madison, Wis. (Forest Products Laboratory)
Oct. 16–17	Committee D-14 on Adhesives	Washington, D. C. (Shoreham Hotel)
Oct. 21–22	Committee C-19 on Structural Sandwich Constructions	Baltimore, Md. (Martin Company)
Oct. 23	Committee D-15 on Engine Antifreezes	Philadelphia, Pa. (Sheraton Hotel)
Oct. 23–24	Committee B-1 on Wires for Electrical Conductors	Washington, D. C. (Sheraton Park Hotel)
Oct. 23–24	Committee B-4 on Metallic Materials for Electrical Heating, Electrical Resistance, and Electrical Contacts	Chicago, Ill. (Morrison Hotel)
Oct. 27–29	Committee D-20 on Plastics	Philadelphia, Pa. (Benj. Franklin Hotel)
Oct. 28–29	Committee B-9 on Metal Powders and Metal Powder Products	Cleveland, Ohio (Manger Hotel)
Oct. 29–31	Committee D-9 on Electrical Insulating Materials	Philadelphia, Pa. (Benj. Franklin Hotel)
Oct. 30	New England District	Cambridge, Mass. (M.I.T.)
Oct. 30–31	International Symposium on Plastics	Philadelphia, Pa. (Benj. Franklin Hotel)
Nov. 5–7	Committee E-13 on Absorption Spectroscopy	New York City (Hotel New Yorker)
Nov. 7	Joint Committee on Chemical Analysis by Powder Diffraction Methods	Pittsburgh, Pa.
Nov. 13–14	Committee F-1 on Materials for Electron Tubes and Semiconductor Devices	Sky Top, Pa. (The Inn)
Nov. 17	Central New York District	Troy, N. Y. (Rensselaer Polytechnic Inst.)
Nov. 19–22	Committee C-13 on Concrete Pipe	Chicago, Ill. (Union League Club)
Nov. 20	Philadelphia District	Villanova, Pa.
Dec. 1–3	Committee C-1 on Cement	Lafayette, Ind. (Purdue Memorial Union)
Dec. 3–5	Committee C-9 on Concrete and Concrete Aggregates	Lafayette, Ind. (Purdue Memorial Union)
Dec. 6	Chicago District	Lafayette, Ind. (Purdue Memorial Union)

Indian Symposium on the Iron and Steel Industry

A SYMPOSIUM on the "Iron and Steel Industry in India" will be held at the National Metallurgical Laboratory, Jamshedpur, India, February 4–7, 1959. Special emphasis will be given to the application of the latest technological and research information to the expansion of India's Iron and Steel Industry, the core of her Second Five Year Plan.

The symposium will cover raw materials, physical chemistry of iron and steel production; recent advances in metallurgy, casting and metal-working techniques; alloy, tool, and special steel production; and utilization of by-products.

An invitation is extended to technologists, metallurgists, and research scientists in India and abroad to attend the symposium or contribute technical papers for discussion.

Development of Test Methods for Flexible Barrier Materials

IT WAS EVIDENT at the meeting of Committee F-2 on Flexible Barrier Materials in New York on April 15 that standardized test methods were the most pressing problem in the fast-growing flexible barrier field. Working groups were therefore formed to investigate water vapor permeability and gas transmission, two properties needing urgent attention. Seal, tear, impact, bursting, and tensile strength are also receiving first consideration. Chemical properties being investigated include analysis, resistance to chemical reaction, biological characteristics, and corrosion inducing or inhibiting properties. The first effort is being directed toward a method for determining moisture content.

The establishment of rigorous definitions is being approached by a literature survey of all terms which have a particular meaning in the flexible barrier field. All terms will be listed and a priority assigned to them.

It was decided that, as a preliminary step, tables of data for flexible barrier materials would be assembled, and from these data a program could be developed to set up necessary specifications.

The new committee is concentrating on the functional characteristics of flexible barrier materials to permit their proper employment by users and fabricators in this field. The task groups established at the last meeting will report their findings at the next meeting of the committee which will be held at the Edgewater Beach Hotel, Chicago, October 15, 1958.

Hussey Elected VP of ISO

VICE-Admiral George F. Hussey, Jr., (Ret), managing director of the American Standards Assn., has been elected vice-president of the International Organization for Standardization at the 1958 triennial meeting of the international standards body in Harrogate, England. Prof. Edward Wegelius, president of the Finish Standards Assn, was elected president of ISO.

ISO provides the means for the development of voluntary international standards for engineering, industry, and commerce. Forty nations are now members of the organization. American interests on international standards work are represented through the American Standards Assn., Inc., New York, N. Y. ASTM interests are represented on more than 20 of the ISO technical committees.

NEW ASTM PUBLICATIONS

Proceedings of Conference on Soils for Engineering Purposes

This conference on soils was reported upon in this publication sponsored jointly by ASTM Committee D-18 on Soils for Engineering Purposes, and the Sociedad Mexicana de Mecanica de Suelos, A.C. It was held the second week of December, 1957, at the University of Mexico in Mexico City.

A wide range of subject matter is covered in this group of 15 papers, equally divided between authors from Mexico and the United States. Such important topics as sampling equipment, consolidation, compaction and compaction control, soil strength, and other associated and significant properties are discussed. Interesting contributions from Mexican authors include information on the consolidation of Mexico City volcanic clay, investigation of a volcanic soil for the construction of an earth dam, and the underpining and straightening of an eleven-story building in Mexico City.

Soil deformations under repeated stress applications, developments in soil sampling and rock-coring equipment, testing soils with transient loads and compaction characteristics of gravelly soils are covered in some of the papers by authors from the United States.

In additon, an important part of the book is devoted to extensive discussion of the papers by leading authorities in the field. The book contains both English and Spanish versions of each paper.

STP232; 500 pages; paper cover, 8½ by 11 in.; price $9.00; to ASTM and SMMS members, $7.20.

Symposium on the Compositions of Petroleum Wax

This symposium, sponsored by the TAPPI-ASTM Technical Committee on Petroleum Waxes, was held February 19, 1958, in New York, N. Y. The symposium publication makes available data relating the compositions of waxes to performance as determined by ASTM and TAPPI wax testing procedures. Data and explanations are given which help to clarify the relation of the functional and physical properties of the wax to composition and stability.

CONTENTS

This symposium was reprinted from the June, 1958, edition of *Tappi*.

52 pages; self-cover; 8½ by 11 in. price $1.50; to members, $1.00

1957 References on Fatigue

This list of references, consisting of about 375 entries, provides an extensive source of information on papers published in 1957 dealing with fatigue of structures and material. An abstract of each reference is included in all but a few cases. The material is so arranged that individual references can be cut apart for filing according to any desired plan. This publication is sponsored by Subcommittee III of ASTM Committee E-9 on Fatigue.

Similar lists of references were published covering the years 1950 through 1956 and are available, from ASTM Headquarters, in a package purchase with the current edition for $12.50.

STP 9-I, 64 pages; multilithed; self cover; 8½ by 11 in.; price $3.

Electrodeposited Metallic Coatings

Compilation of Standards, B-8

This compilation of ASTM Standards covers such materials as electrodeposited zinc, cadmium, nickel, chromium, and lead for steel. In addition, coatings for copper, copper-base alloys, zinc, and zinc-base alloys are also covered. This edition supersedes the 1955 edition.

Several methods of tests including salt spray, local thickness and acetic acid spray tests are included. To make the book more useful, recommended practices for preparing metals for plating are included. These include plating for low-carbon steel, high-carbon steel, aluminum alloys, zinc-base die castings, iron castings, etc.

The book contains seven specifications, three methods of test, and nine recommended practices. Of the 19 standards, ten are new, recently revised, or have had their status changed since the last edition.

ASTM Standards on Electrodeposited Metallic Coatings (1958 Edition); 124 pages; paper cover; price $2.25; to members, $1.80.

Gaseous Fuels

Compilation of Standards, D-3

This compilation of standards on gaseous fuels replaces the edition issued in 1954. It contains four methods for sampling and measurement and nine methods of testing and analysis. Of these, seven are new, revised, or have had their status changed since the last edition. Natural gas, manufactured gas, and liquefied petroleum gases are the materials for which these standards were written.

ASTM Standards on Gaseous Fuels (1958 Edition); 280 pages; paper cover; price $3; to members, $2.40.

Errata in Price of ASTM X-Ray Powder Data Cards

The prices appearing in the April ASTM Bulletin for Section 8 of the X-Ray Powder Data Card File should have been:

	Plain	Keysort
Inorganic Part	$70	$100
Organic Part	$50	$90

Improved IBM cards, carrying the name of the compound, are in process. Prices are available on request.

ACR Notes

BY W. H. LUTZ[1]

Administrative Committee on Research

A Boston Landmark and Materials Research

PROBABLY few ASTM members who attended the Society's 1958 Annual Meeting had occasion to walk in Marshall Lane. If any did so, their curiosity might have been aroused by a granite ball that is embedded in the side of an old building on this typically narrow Boston street. Directly below the ball is a granite block bearing the inscription, "Boston Stone—1797." The Boston Stone is all that remains of the first paint mill in Colonial America. Brought from England sometime in 1693, the Boston Stone was installed in front of the shop of Thomas Child, a house painter. He—or more probably an apprentice—made paint by rolling the granite ball back and forth in a stone trough containing pigment and linseed oil. Thomas Child had to make his own paint; ready-mixed paint, such as we have today, was then unknown.

If Thomas Child had any quality standards or employed any test methods to control his product, no one now knows. It seems reasonable to assume however, that Thomas Child had technical problems. His selection of raw materials was extremely limited, and succeeding shipments of materials must have exhibited wide variations. His paint batches undoubtedly differed in smoothness, gloss, and consistency. They would have displayed annoying differences in drying behavior, because soluble paint driers had not yet been discovered. Even if Thomas Child had been motivated by a desire to exchange technical views with other paint compounders, he would have had difficulty in finding any, and they most certainly would have resented his approaches. Thomas Child did not live in the

enlightened twentieth century; he lived at a time when paint-making was an art and when each artisan carefully guarded his trade secrets.

In the 265 years that have elapsed since the Boston Stone was first used, paint making has become a science, production facilities have been mechanized, and electric motors have replaced apprentices as a power source. Not all technical problems have been solved. The basic operation in paint making—dispersion of small particles of pigment in the vehicle, or liquid portion of the paint—continues to be the subject of investigation by engineers, chemists, and production men. Fortunately, these people now have a convenient tool for measuring degree of disperson. Incidentally, paint people traditionally refer to degree of dispersion as "fineness of grind," although they know that dispersion does not reduce the particle size of any pigment. Degree of dispersion is determined by ASTM Test Method D 1210 – 54. Degree of dispersion measurements help to establish grinding efficiency, as well as batch "fineness."

Paint manufacturers and users have a multitude of other ASTM methods for testing and evaluating qualities such as consistency, gloss, color, drying, abrasion resistance, and durability. All these tests have been developed since 1902, when the Society passed a resolution to collect data on and prepare specifications for paints to protect iron and steel from rust. This task was assigned to Committee E (now Committee D-1 on Paint, Varnish, Lacquer, and Related Materials) and led to tests on the Havre de Grace bridge—the first extensive cooperative paint exposure tests. Today, twenty subcommittees of Committee D-1 are exploring every facet of paint technology through round robin tests and other cooperative research. ASTM has done much to advance progress in the paint industry.

It sometimes takes a Boston Stone to place ASTM research accomplishments in proper perspective. Research has been the life-blood of ASTM and, therefore, it is not strange that the Society's second oldest administrative committee is ACR. The functions of ACR are to consider means for promoting knowledge of engineering materials, to encourage or "catalyze" research in materials, and to review progress in the Society's research activities. A major concern of ACR, at the present time, is the large volume of technical committee research that goes unpublicized. It is difficult for technical committees to sift out the small nuggets of new knowledge from all the routine test data that accumulate at the end of each year's work. ACR is cognizant of the difficulty, but urges technical committees to look more closely into their files for buried, but valuable, unpublished research.

[1] Vice-president, Pratt & Lambert, Inc., Buffalo, N. Y.

Prize-Winning Photographs

Eleventh Photographic Exhibit

Many of these prize-winning photographs from the 1958 Annual Meeting exhibit will appear in future issues of the BULLETIN.

General

Black and White or Monochrome

FIRST: *Demonstration of the Low Density of Aluminum Foam*, Richard M. Reese, Bjorksten Research Laboratories, Inc., Madison, Wis.

SECOND: *Regenerator Model Flow Pattern Depicted by Flowing Birefringence Technique*, Jacob Belkin and E. W. Sherwin, United States Steel Corp., Applied Research Laboratory, Monroeville, Pa.

Plastics

FIRST: *Cross-Section of Prepuffed Expandable Polystyrene Bead and Prepuffed Expandable Polystyrene Bead*, Ruth Giuffria, General Electric Co., Louisville, Ky.

SECOND: *Spherulitic Growth of Sugar*, Libera M. Dogliotti, headquarters, Quartermaster R & E Command, Natick, Mass.

Stress Patterns

FIRST: *Residual Plastic Strain Pattern in Metal after Impression from Cylinder*, Andre Vinckier, Westinghouse Electric Corp., Pittsburgh, Pa.

Super Alloys

FIRST: *Silicon Diffusion into Inconel "X,"* James Nelson, Westinghouse Electric Corp., East Pittsburgh, Pa.

SECOND: *Incoloy Sheathed Heating Element, Nichrome 5 Wire, MgO Insulation*, Daniel M. Trollinger, General Electric Co., Louisville, Ky.

THIRD: *Unusual Microstructure of Cr-Ni-Mo-Alloy*, C. J. Bechtoldt and P. D. Sarmiento, National Bureau of Standards, Washington, D. C.

Photomicrographs—Color

FIRST: *Uranium-Carbon Alloy—9.08 per cent Carbon*, Robert J. Gray, Oak Ridge National Laboratory, Oak Ridge, Tenn.

THIRD: *Going Up (Erecting Refinery Fraction Column)*, Edmund F. Hawes, Universal Oil Products Co., Des Plaines, Ill.
HONORABLE MENTION: *Gullet Repair Weld in Circular Saw*, James H. Naser, Jessop Steel Co., Washington, Pa.; *Tyndall Effect*, Daniel R. Condon, United States Testing Co., Inc., Hoboken, N. J.; *Metals Rubbed without Oil*, David N. Collins, Chrysler Corp., Engineering Division, Detroit, Mich.

Color

FIRST: *Spinning Reels*, Daniel R. Condon, United States Testing Co., Inc., Hoboken, N. J.
SECOND: *Resinite—Winifrede Coal—Lynch, Kentucky—Transmitted Light*, R. J. Gray, United States Steel Corp., Monroeville, Pa.
THIRD: *Streak Photographs of 3500 cm per sec Flame Front Interacting with Salt-Coated Screen*, T. G. Lee, National Bureau of Standards, Washington, D. C.

Color Transparencies

FIRST: *Arc-Welding Stainless Steel Reactor Components*, Eugene S. Clarke, United Shoe Machinery Corp., Beverly, Mass.
SECOND: *Emergency Stop*, Robert H. Sozanski, United States Steel Corp., Applied Research Laboratory, Monroeville, Pa.
THIRD: *Thermo-Fluid Catalyst Cracking Unit*, John H. Rudd, Richfield Oil Corp., Wilmington, Calif.

Photoelastic Patterns

FIRST: *Photo-Stress Pattern Cross Section of Sheet Piling Subjected to Tensile Load (Structural Steel)*, F. Zandman, Tatnall Measuring Systems Co., Phoenixville, Pa.

Photomicrographs—Black and White

FIRST: *Microstructure of a High-Temperature Alloy Brazed Joint Interface*, James Nelson, Westinghouse Electric Corp., East Pittsburgh, Pa.
SECOND: *Simplified Standard for Rating Delta Ferrite in 12 Per Cent Chromium Steel*, Francis E. Bates, General Electric Co., Lynn, Mass.
THIRD: *Twinning in Zone-Purified Silicon Rod*, John H. Miller, Sylvania Electric Products, Inc., Towanda, Pa.
HONORABLE MENTION: *Calcium-Lead Alloy*, Oliver E. Olsen, National Lead Co., Brooklyn, N. Y.

Corrosion

FIRST: *Zinc-Whiskers on a Galvanized Steel Wire Paper Clip*, E. W. Sherwin, United States Steel Corp., Monroeville, Pa.
SECOND: *Blistering, Resulting from Corrosive Attack Along Weld Zone*, James H. Naser, Jessop Steel Co., Washington, Pa.

Fibers

FIRST: *Damaged Fabric*, Daniel R. Condon, United States Testing Co., Inc., Hoboken, N. J.
SECOND: *Cross Section of Expandable Polystyrene Bead Foam*, Ruth Giuffria, General Electric Co., Louisville, Ky.

Methods

FIRST: *General Time-Lapse Photography of Tin-Whisker Growth*, E. P. Morgan and A. G. Lee, United States Steel Corp., Monroeville, Pa.
SECOND: *Gas Evolves from Propagating Fatigue Crack Under Transparent Tape*, Ruth E. Dowden, National Bureau of Standards, Washington 25, D. C.
THIRD: *Orientation of Random Grains Revealed by Film Cracking*, and *Orientation of Twin-Columnar Grains Revealed by Film Cracking*, Glenn R. Frank, Jr., Aluminum Company of America, New Kensington, Pa.

Non-Metallics

HONORABLE MENTION: *Effect of Temperature on Growing Crystal Habit of D.D.T.*, W. C. McCrone, Jr., W. C. McCrone Associates, Chicago, Ill.

Color Transparencies—Metallics

FIRST: *Titanium Nitride Inclusions in Grey Cast Iron*, Charles R. Kenyon, Sheffield Steel, Kansas City, Mo.
SECOND: *Contrasting Microstructure of a Slow-Cooled 10.5 Per Cent Al and 12.9 Per Cent Al Aluminum Bronze*, James Nelson, Westinghouse Electric Corp., East Pittsburgh, Pa.

Color Transparencies—Non-Metallics

FIRST: *Crystals Sublimed from Fusion of Oil Extracted Crystals from Mylar Film*, Ruth Giuffria, General Electric Co., Louisville, Ky.
SECOND: *Fused D.D.T.*, Ralph J. Hinch, Jr., Armour Research Foundation, Chicago, Ill.

Electron Micrographs

Non-Metals

FIRST: *Graphite Whisker with Moiré Pattern*, H. K. Meyer and James Ruggiero, National Carbon Co., Cleveland, Ohio
SECOND: *Chalked Enamel*, W. L. Weeks, F. O. Thomas, and D. M. Teague, Chrysler Corp., Detroit, Mich.
THIRD: *Two Stage Carbon Replica of Collagen Fibers in Pickled Sheepskin*, William S. Bertaud, Dominion Physical Laboratory, Lower Hutt, New Zealand
HONORABLE MENTION: *Preshadowed Carbon Replica of Du Pont Crystal Violet Dye*, Walter S. Kay, Jackson Laboratory, E. I. du Pont de Nemours and Co., Inc., Wilmington, Del.

Metals

FIRST: *Zirconium-Niobium [Columbium] Alloy*, W. H. Bridges, E. L. Long, Jr., and J. T. Houston, Oak Ridge National Laboratory, Oak Ridge, Tenn.
SECOND: *Spiral Structure of Cubical Etch Pit in 50 Per Cent Ni-50 Per Cent Fe Alloy*, Robert M. Slepian and N. I. Ananthanarayanan, Westinghouse Electric Corp., East Pittsburgh, Pa.
THIRD: *Aging Precipitate in Inconel-X as Revealed by Electron Microscope Techniques*, J. R. Mihalisin and R. P. Morenski, The International Nickel Co., Inc., Bayonne, N. J.

Student Entries

Photomicrographs—Black and White

FIRST: *Subgrains in Pure Iron*, Charles Hays, University of Kentucky, Lexington, Ky.

Electron Microscope

FIRST: *Spiral Thickenings and Pits in a Basswood Vessel Segment, Fungal Hypha in the Wall of a Basswood Vessel Segment, and Warty Lining Microfibrillar Wall Structure in a Port-Oxford-Ceder Tracheid*, Wilfred A. Côté, Jr., State University of New York, Syracuse, N. Y.

Special Award

HONORABLE MENTION: *The Vitron*, William L. Smallwood, National Bureau of Standards, Washington, D. C.

Special Educational Award

FIRST: *Stereo-Photography Developed for Better Visual Standards*, Department of the Navy, Bureau of Ships, Washington 25, D. C.

New Committee on Halogenated Solvents

V. E. AMSPACHER, chief chemist of the Pennsylvania Railroad, and Mrs. Wanda L. Campbell, chief Chemist of Chemicals and Materials Corp., were elected chairman and secretary respectively of ASTM Committee D-26 on Halogenated Organic Solvents at the organization meeting on June 26, in Boston. Fred G. Low of the du Pont Co., who was elected vice-chairman, has subsequently been transferred to another department and will not be able to serve the committee in this capacity. The committee will elect an other vice-chairman.

The committee approved the following scope and subcommittee organization:

Scope.—The promotion of knowledge pertaining to halogenated organic solvents and admixtures thereof including formulation of specifications, definitions, and methods of test.

Standards peculiar to electrical insulating liquids, paint thinners, and nonhalogenated components of admixtures normally are excluded from the scope of Committee D-26. Developments in these and other fields incidental to the work of the committee will be coordinated with the appropriate technical committees of the Society.

Subcommittees were established as follows: Executive, Definitions and Nomenclature, Vapor Degreasing, Cold Cleaning, Test Methods, and Industrial Hygiene and Safety.

The organization meeting approved a membership list for the committee totaling 44 members. Of this number there are 22 producers, 20 consumers and 2 general interest members. A complete list will appear in the 1958 ASTM Yearbook.

NBS Rubber Standards

Two new standard samples have been added to the National Bureau of Standards' list of materials for rubber compounding. They are: No. 383, mercaptobenzothiazole, priced at $2.75 for an 800 g sample, and No. 385, natural rubber, priced at $44 for sample of about 31,500 g. These standard samples are important additions to the materials needed to prepare ASTM standard rubber compounds as described in Methods of Sample Preparation for Physical Testing of Rubber Products (D15 – 57 T).

Technical Committee Officers

LISTED below are chairmen and secretaries of all ASTM technical committees. The 1958 ASTM Year Book contains complete lists of officers and personnel of the various committees. The asterisk indicates new officers.

Committee	Chairman	Secretary
A-1 on Steel	*J. J. Kanter, Crane Co., Chicago, Ill.	H. L. Fry, Bethlehem Steel Co., Inc., Bethlehem, Pa.
A-2 on Wrought Iron	L. S. Crane, Southern Railway System, Washington, D. C.	O. M. Tishlarich, A. M. Byers Co., Pittsburgh, Pa.
A-3 on Cast Iron	*T. E. Egan, Cooper-Bessemer Corp., Grove City, Pa.	*H. W. Lownie, Jr., Battelle Memorial Inst., Columbus, Ohio
A-5 on Corrosion of Iron Steel	*H. F. Hormann, Consolidated Edison Co. of New York, Inc., New York, N. Y.	C. P. Larrabee, United States Steel Corp., Monroeville, Pa.
A-6 on Magnetic Properties	A. C. Beiler, Westinghouse Electric Corp., Pittsburgh, Pa.	W. S. Eberly, Carpenter Steel Co., Reading, Pa.
A-7 on Malleable Iron Castings	W. M. Albrecht, Chain Belt Co., Milwaukee 1, Wis.	J. H. Lansing, Shaker Heights, Ohio
A-9 on Ferro Alloys	S. W. Poole, Republic Steel Corp., Canton, Ohio	W. H. Mayo, United States Steel Corp., Pittsburgh, Pa.
A-10 on Iron-Chromium Iron - Chromium-Nickel and Related Alloys	*L. L. Wyman, National Bureau of Standards, Washington, D. C.	*L. B. Fonda, General Electric Co., Everett, Mass.
B-1 on Wires for Electrical Conductors	D. Halloran, Consolidated Edison Co. of New York, Inc., New York, N. Y.	A. A. Jones, Anaconda Wire and Cable Co., Hastings-on-Hudson, N. Y.
B-2 on Non-Ferrous Metals and Alloys	B. W. Gonser, Battelle Memorial Inst., Columbus, Ohio	A. M. Bounds, Superior Tube Co., Norristown, Pa.
B-3 on Corrosion of Non-Ferrous Metals and Alloys	K. G. Compton, Bell Telephone Laboratories, Inc., Murray Hill, N. J.	A. W. Tracy, The American Brass Co., Waterbury, Conn.
B-4 Metallic Materials for Electrical Heating, Electrical Resistance, and Electrical Contacts	E. I. Shobert, II, Stackpole Carbon Co., St. Marys, Pa.	C. K. Strobel, Westinghouse Electric Corp., Pittsburgh, Pa.
B-5 on Copper and Copper Alloys	*W. H. Jennings, Western Electric Co., Inc., Chicago, Ill.	L. H. Adam, Frankford Arsenal, Philadelphia, Pa.
B-6 on Die-Cast Metals and Alloys	W. Babington, Bell Telephone Laboratories, Inc., Murray Hill, N. J.	G. L. Werley, The New Jersey Zinc Co., Palmerton, Pa.
B-7 on Light Metals and Alloys, Cast and Wrought	I. V. Williams, Bell Telephone Laboratories, Inc., Murray Hill, N. J.	R. B. Smith, Reynolds Metals Co., Richmond, Va.
B-8 on Electrodeposited Metallic Coatings	C. H. Sample, The International Nickel Co., Inc., New York, N. Y.	D. M. Bigge, Chrysler Corp., Detroit, Mich.
B-9 on Metal Powders and Metal Powder Products	J. L. Bonanno, The Lionel Corp., Irvington, N. J.	C. G. Johnson, Presmet Corp., Worcester, Mass.

Committee	Chairman	Secretary
C-1 on Cement	R. R. Litehiser, Ohio State Highway Testing Laboratory, Columbus, Ohio	*W. J. McCoy, Lehigh Portland Cement Co., Allentown, Pa.
C-2 on Magnesium Oxychloride and Oxysulfate Cements	E. S. Newman, National Bureau of Standards, Washington, D. C.	K. M. Berg, Westvaco Mineral Products Div., Food Machinery and Chemical Corp., New York, N. Y.
C-3 on Chemical Resistant Mortars	*J. R. Allen, E. I. du Pont de Nemours and Co., Inc., Wilmington, Del.	E. A. Reineck, The Quaker Oats Co., Chicago, Ill.
C-4 on Clay Pipe	*D. G. Miller, University of Minnesota, St. Paul, Minn.	R. G. Scott, Clay Products Assn., Barrington, Ill.
C-7 on Lime	J. A. Murray, Massachusetts Institute of Technology, Cambridge, Mass.	*L. E. Johnson, Finishing Lime Assn. of Ohio, Toledo, Ohio
C-8 on Refractories	J. J. Hazel, Republic Steel Corp., Cleveland, Ohio	L. J. Trostel, General Refractories Co. Laboratories, Baltimore, Md.
C-9 on Concrete and Concrete Aggregates	W. H. Price, U. S. Bureau of Reclamation, Denver, Colo.	Bryant Mather, Waterways Experiment Station, Jackson, Miss.
C-11 on Gypsum	G. W. Josephson, U. S. Bureau of Mines, Washington, D.C.	*R. H. Faber, Gypsum Assn., Chicago, Ill.
C-12 on Mortars for Unit Masonry	R. E. Copeland, National Concrete Masonry Assn., Chicago, Ill.	C. U. Pierson, Jr., Southern Cement Co., Birmingham, Ala.
C-13 on Concrete Pipe	R. R. Litehiser, Ohio State Highway Testing Laboratory, Columbus, Ohio	H. F. Peckworth, American Concrete Pipe Assn., Chicago, Ill.
C-14 on Glass and Glass Products	L. G. Ghering, Preston Laboratories, Inc., Butler, Pa.	F. V. Tooley, University of Illinois, Urbana, Ill.
C-15 on Manufactured Masonry Units	J. W. Whittemore, Virginia Polytechnic Inst., Blacksburg, Va.	M. H. Allen, Structural Clay Products Research Foundation, Geneva, Ill.
C-16 on Thermal Insulating Materials	W. L. Gantz, Am. Viscose Corp., Philadelphia, Pa.	J. M. High, Mundet Cork Corp., New York, N. Y.
C-17 on Asbestos-Cement Products	W. V. Friedlaender, Universal Atlas Cement Div., Gary, Ind.	C. C. Kelsey, Asbestos-Cement Products Assn., New York, N. Y.
C-18 on Natural Building Stones	L. W. Currier, U. S. Geological Survey, Washington, D. C.	F. S. Eaton, Research and Design Inst., New Haven, Conn.
C-19 on Structural Sandwich Constructions	*T. P. Pajak, Narmco Industries, Inc., Bel Air, Md.	*J. H. Gibbud, Owens-Corning Fiberglas Corp., Ashton, R. I.
C-20 on Acoustical Materials	*R. N. Hamme, Geiger & Hamme, Ann Arbor, Mich.	*Ralph Huntley, Armour Research Foundation, Geneva, Ill.
C-21 on Ceramic Whitewares and Related Products	M. D. Burcick, National Bureau of Standards, Washington, D. C.	*G. W. Phelps, United Clay Mines Corp., Trenton, N. J.
C-22 on Porcelain Enamel	W. N. Harrison, National Bureau of Standards, Washington, D. C.	G. H. Spencer-Strong, Pemco Corp., Baltimore, Md.
C-23 on Sorptive Mineral Materials	*A. R. Balden, Chrysler Corp., Detroit, Mich.	*R. L. Shirley, The Eagle-Picher Co., Cincinnati, Ohio
D-1 on Paint, Varnish, Lacquer and Related Products	W. T. Pearce, Bala-Cynwyd, Pa.	W. A. Gloger, National Lead Co., Brooklyn, N. Y.
D-2 on Petroleum Products and Lubricants	Harold M. Smith, U. S. Bureau of Mines, Bartlesville, Okla.	W. T. Gunn, American Petroleum Inst., New York, N. Y.

Committee	Chairman	Secretary
D-3 on Gaseous Fuels	*D. V. Kniebes, Chicago, Ill.	*K. R. Knapp, Cleveland Heights, Ohio
D-4 on Road and Paving Materials	*A. B. Cornthwaite, Virginia Dept. of Highways, Richmond, Va.	J. M. Griffith, The Asphalt Inst., College Park, Md.
D-5 on Coal and Coke	O. W. Rees, Illinois State Geological Survey, Urbana, Ill.	*R. L. Coryell, Consolidated Edison Co. of N. Y., New York, N. Y.
D-6 on Paper and Paper Products	R. H. Carter, General Electric Co., Schenectady, N. Y.	R. E. Green, Thwing-Albert Instrument Co., Philadelphia, Pa.
D-7 on Wood	L. J. Markwardt, U. S. Forest Products Laboratory, Madison, Wis.	L. W. Smith, U. S. Forest Service, Washington, D. C.
D-8 on Bituminous Materials for Roofing, Waterproofing, and Related Building or Industrial Uses	H. R. Snoke, National Bureau of Standards, Washington, D. C.	G. W. Robbins, The Texas Company, New York, N. Y.
D-9 on Electrical Insulating Materials	H. K. Graves, New York Naval Shipyard, Brooklyn, N. Y.	J. E. Gibbons, 311 E. Hinckley Ave., Ridley Park, Pa.
D-10 on Shipping Containers	*J. G. Turk, Glass Container Manufacturing Inst., Lansing, Mich.	R. F. Uncles, American Cyanamid Co., New York, N. Y.
D-11 on Rubber and Rubberlike Materials	Simon Collier, Johns-Manville Corp., New York, N. Y.	J. J. Allen, Firestone Industrial Products Co., Akron, Ohio
D-12 on Soaps and Other Detergents	J. C. Harris, Monsanto Chemical Co., Dayton, Ohio	*H. R. Suter, Wyandotte Chemicals Corp., Wyandotte Mich.
D-13 on Textile Materials	B. L. Whittier, North Carolina State College, Raleigh, N. C.	H. A. Ehrman, Kensington, Md.
D-14 on Adhesives	*J. E. Rutzler, Jr., Case Inst. of Technology, Cleveland, Ohio	J. J. Lamb, Radio Corp. of America, Camden, N. J.
D-15 on Engine Antifreezes	*R. E. Vogel, Standard Oil Co. (Ind.), Chicago, Ill.	*C. O. Durbin, Chrysler Corp., Detroit, Mich.
D-16 on Industrial Aromatic Hydrocarbons	*W. E. Sisco, American Cyanamid Co., Organic Chemicals Div., Bound Brook, N. J.	*K. H. Ferber, National Aniline Div., Allied Chemical Corp., Buffalo, N. Y.
D-17 on Naval Stores	*S. R. Snider, U. S. Dept. of Agriculture, Tobacco Div., AMS, Washington, D. C.	W. A. Kirklin, Hercules Powder Co., Wilmington, Del.
D-18 on Soils for Engineering Purposes	E. J. Kilcawley, Rensselaer Polytechnic Inst., Troy, N. Y.	W. G. Holtz, Bureau of Reclamation, Denver, Colo.
D-19 on Industrial Water	Max Hecht, 417 W. Upsal St., Philadelphia, Pa.	O. M. Elliott, Sun Oil Co., Philadelphia, Pa.
D-20 on Plastics	F. W. Reinhart, National Bureau of Standards, Washington, D. C.	*R. M. Berg, Union Carbide Chemicals Co., S. Charleston, W. Va.
D-21 on Wax Polishes and Related Materials	W. W. Walton, National Bureau of Standards, Washington, D. C.	B. S. Johnson, Franklin Research Co., Philadelphia, Pa.
D-22 on Methods of Atmospheric Sampling and Analysis	*Leslie Silverman, Harvard University, School of Public Health, 55 Shattuck St., Boston, Mass.	*A. T. Rossano, Jr., Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio
D-23 on Cellulose and Cellulose Derivatives	F. A. Simmonds, U. S. Forest Products Laboratories, Madison, Wis.	W. W. Becker, Hercules Powder Co., Wilmington, Del.
D-24 on Carbon Black	*N. T. Bekema, United States Rubber Co., Detroit, Mich.	*T. D. Bolt, Godfrey L. Cabot, Inc., Boston, Mass.
D-25 on Casein and Similar Protein Materials	H. W. Shader, Armstrong Cork Co., Lancaster, Pa.	*L. E. Georgevits, The Borden Chemical Co., Div. of The Borden Co., Bainbridge, N. Y.
D-26 on Halogenated Organic Solvents	*V. E. Amspacher, The Pennsylvania Railroad Co., Altoona, Pa.	*Wanda L. Campbell, Chemicals and Materials Corp., Terre Haute, Ind.
E-1 on Methods of Testing	*A. C. Webber, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.	P. J. Smith, American Society of Testing Materials, Philadelphia, Pa.
E-2 on Emission Spectroscopy	D. L. Fry, General Motors Corp., Detroit, Mich.	C. Feldman, Oak Ridge National Laboratory, Oak Ridge, Tenn.
E-3 on Chemical Analysis of Metals	Arba Thomas, Armco Steel Corp., Middletown, Ohio	H. Kirtchik, General Electric Co., Evendale, Ohio
E-4 on Metallography	L. L. Wyman, National Bureau of Standards, Washington, D. C.	Mary R. Norton, Watertown Arsenal, Watertown, Mass.
E-5 on Fire Tests of Material and Construction	W. J. Krefeld, Columbia University, New York, N. Y.	H. D. Foster, New York State Bldg., Code Commission, New York, N. Y.
E-6 on Methods of Testing Building Constructions	R. F. Legget, National Research Council of Canada, Ottawa, Ont., Canada	R. A. Biggs, Electro Metallurgical Co., Div. of Union Carbide Corp., New York, N. Y.
E-7 on Nondestructive Testing	J. H. Bly, High Voltage Engineering Corp., Burlington, Mass.	Alexander Gobus, Philips Electronics, Inc., Mt. Vernon, N. Y.
E-8 on Nomenclature and Definitions	P. V. Faragher, Oakmont, Pa.	P. J. Smith, American Society for Testing Materials, Philadelphia, Pa.
E-9 on Fatigue	R. E. Peterson, Westinghouse Electric Corp., Pittsburgh, Pa.	O. J. Horger, The Timken Roller Bearing Co., Canton, Ohio
E-10 on Radioisotopes and Radiation Effects	*C. E. Weber, General Electric Co., Schenectady, N. Y.	J. R. Bradford, Texas Technological College, Lubbock, Texas
E-11 on Quality-Control of Materials	*S. Collier, Johns-Manville Corp., New York, N. Y.	*J. H. Davidson, General Electric Co., Schenectady, N. Y.
E-12 on Appearance	*G. W. Ingle, Monsanto Chemical Co., Plastics Div., Springfield, Mass.	R. S. Hunter, Hunter Associates Laboratory, McLean, Va.
E-13 on Absorption Spectroscopy	E. J. Rosenbaum, Drexel Institute of Technology, Philadelphia, Pa.	R. F. Robey, Esso Laboratories, Esso Research and Engineering Co., Linden, N. J.
E-14 on Mass Spectrometry	*R. A. Friedel, U. S. Bureau of Mines, Pittsburgh, Pa.	*R. A. Brown, Atlantic Refining Co., Philadelphia, Pa.
F-1 on Materials for Electron Tubes and Semiconductor Devices	S. A. Standing, Raytheon Manufacturing Co., Quincy, Mass.	Stanton Umbreit, Radio Corp. of America, Harrison, N. J.
F-2 on Flexible Barrier Materials	*C. C. Sutton, General Foods Research Center, Tarrytown, N. Y.	*T. M. Hill, Aluminum Company of America, Pittsburgh, Pa.

New Committee on Industrial Chemicals

A NEW Committee on Analysis and Testing of Industrial Chemicals is now in process of organization, as authorized in May by the Board of Directors. The Society has long been concerned with chemical analysis as one of the aspects of testing materials. Practically every one of the 80 technical committees has at least one sub-group concerned specifically with chemical analysis and many of the committees are dealing with industrial chemicals in one form or another. The new committee is not intended to take over any of these going activities in the technical committees but will assist where feasible in coordinating matters of common interest.

The new committee will provide a forum for discussion of chemical and analytical problem and will promote the development of standards in areas not presently covered in ASTM technical committees but for which there is an industry need. The Board of Directors has designated the Society's Advisory Committee on Industrial Chemicals, W. A. Kirklin, chairman, as the organizing committee for the new Committee E-15 on Analysis and Testing of Industrial Chemicals. The scope of the new committee, as approved by the Board of Directors, is as follows:

(*a*) To develop or formulate standard methods for the analysis and testing of industrial chemicals,

(*b*) In cooperation with other committees (of the ASTM), to coordinate and reconcile chemical analytical methods for nonmetallic materials and chemicals that are broadly applicable,

(*c*) To encourage the use of uniform methods of analysis,

(*d*) To formulate standards for nomenclature, definitions, and methods of sampling pertaining to analysis and testing of industrial chemicals,

(*e*) To establish precision and accuracy of standard analytical and test methods for chemicals, and

(*f*) To encourage the establishment of new product committees in the field of industrial chemicals when needs become evident.

Note.—*Specifications are specifically excluded* from the scope of this committee.

The organizing committee and the Staff are currently developing a list of interested organizations and individuals to be invited to an organization meeting of the committee. Anyone interested in participating in this committee's activities should write to ASTM Headquarters.

Challenges in Materials Research

Oxide Coating Adhesion on Cathode Sleeves in Electron Tubes

Contributed by Committee F-1 on Materials for Electron Tubes and Semiconductor Devices

The Administrative Committee on Research sponsors the publication from time to time in the BULLETIN of statements of problems in the materials field representing challenges in materials research. It is hoped that by disseminating such information on materials research problems, contributions toward their solution might be forthcomnig from sources outside the membership of the committee originating the problem. Comments and suggestions are welcome and will be forwarded to the originating committee.

Problem

One basic requirement for a good electron tube is that the oxide coating shall be tightly adherent to the nickel cathode sleeve. When this requirement is not fully met, a condition described as coating peel exists. Coating peel can occur to various degrees ranging from the worst condition where all or a portion of the coating becomes detached from the cathode, to the condition where the coating bond between the coating and cathode is not tight. There is no known method for measuring quantitatively the adherence of the coating to the cathode sleeve nor is there yet a method to determine when and to what degree coating peel occurs. Furthermore, the nature of the bond between the nickel sleeve and the coating is not known nor is there a manufacturing procedure which will consistently eliminate poor coating adherence.

Present State of Knowledge

The cathode used in an electron tube usually consists of a nickel sleeve coated with a mixture of alkaline earth carbonates in a binder material. While on a vacuum system, the electron tube is processed in part by heating the cathode, which results in the burning off of the binder, decomposition of the carbonates to the oxides, and the beginning of a chemical reaction between the oxides and the cathode base metal. After this treatment of the cathode, designed to bring it to a condition of maximum electron emission, the coating should have formed an adherent bond to the nickel sleeve. Sometimes the bond does not properly form or may deteriorate during the life of the electron tube, resulting in coating peel. It is known that coating adherence can be improved by following certain empirical rules concerning chemical composition of tube components, cleaning requirements to condition the cathode sleeve surfaces, preparation and application technique pertaining to the coating, and electron tube processing on exhaust and test. There is, however, much conflicting data and no real understanding of the nature of the coating-cathode bond.

Questions That Need to Be Answered

1. Can methods be developed, both destructive and nondestructive, that will quantitatively measure the adherence or lack of adherence between the cathode and its coating.

2. What is the mechanism that causes the coating to bond to the cathode sleeve during processing?

3. What is the effect of each of the many individual factors that are known to influence the coating adherence, a few of which are:

(a) chemical composition of component parts,

(b) composition and physical state of the coating,

(c) preparation of cathodes prior to spraying,

(d) environmental conditions during coating applications, and

(e) exhaust processing techniques employed to activate the cathode and to assure a good vacuum in the finished electron tube.

Introductory References

(1) A. Eisenstein, "A Study of Oxide Cathodes by X-Ray Diffraction Methods," *Journal of Applied Physics*, Vol. 17, pp. 434–443 (1946).

(2) F. R. Michael, "Tube Failures in ENIAC," *Electronics*, Vol. 20, pp. 116–119 (1947).

(3) W. Raudorf, "Changes of Mutual Conductance with Frequency," *Wireless Engineer*, Vol. XXVI, pp. 331–337 (1949).

(4) G. Herrmann and S. Wagener, "The Oxide-Coated Cathode," Chapman and Hall, London, Vol. 1 (1951).

(5) B. S. Cooper and H. E. Bullen, "Electron Diffraction," *G.E.C. Journal*, Gen. Electric Co., Ltd. (England), Vol. 23, pp. 00–136 (1956).

Additional information may be obtained from C. C. Powers, General Electric Co., Owensboro, Kentucky.

District Activities

Howard E. Montgomery

ROCKY MOUNTAIN

New District Organized

A new ASTM District, encompassing the states of Wyoming, Colorado, Utah, Arizona, and New Mexico and a small portion of Texas, has been formed. The district, designated as the Rocky Mountain District, is in the process of electing a permanent council. The chairman pro tem of the district is Howard E. Montgomery, Sandia Corp., Sandia Base, Albuquerque, N. Mex.

The formation of this district followed an outstanding one-day symposium on the Life Properties of Materials held in Albuquerque in January, 1958. The keen interest displayed at this meeting by engineers and scientists from all parts of this area demonstrated to the Board of Directors the rapid industrialization of these states. In cognizance of this development the new district was authorized by the Board at its May meeting.

CENTRAL NEW YORK

First Meeting Planned

Following an extensive study, the Board of Directors has authorized the formation of a Central New York District which will be composed of the counties of New York State lying north of the line of Sullivan, Ulster, and Duchess and east of Wayne, Seneca, Schuyler, and Chemung. Such important industrial centers as Syracuse, Rome, Utica, Endicott, Binghamton, and Schenectady are included in the district.

The district was formed from portions of the Western New York-Ontario and the New York Districts in recognition of the heavy concentration of industry throughout the Mohawk Valley area. The chairman pro tem of the new district is B. F. Richardson, Chief Metallurgist, Utica Metals Division, Utica Drop Forge and Tool, Utica, N. Y.; secretary pro tem is W. A. Mader, Oberdorfer Foundries, Syracuse, N. Y. Elections for a permanent council are presently under way. Nominates for office are: G. H. Harnden, consultant, Engineering Services Division, General Electric Co., Schenectady, N. Y., chairman; B. F. Richardson, vice-chairman; J. S. Meyer, Metallurgical Laboratory, International Business Machines Corp., Endicott, N. Y., vice-chairman; E. J. Kilcawley, professor and head, Division of Soil Mechanics and Sanitary Engineering, Rensselaer Polytechnic Inst., Troy, N. Y., has been asked to serve as secretary. The first official meeting of the district is planned for November at Troy, N. Y., at which time President Woods will be the featured speaker.

B. F. Richardson

Houston Engineering Council Names Chairez Secretary-Treasurer

Frank Chairez, Eastern States Petroleum and Chemical Corp., and secretary of the ASTM Southwest District, has been named secretary-treasurer of the Houston Engineering Council. This organization represents 9000 members of 28 engineering and technical societies in the Houston area.

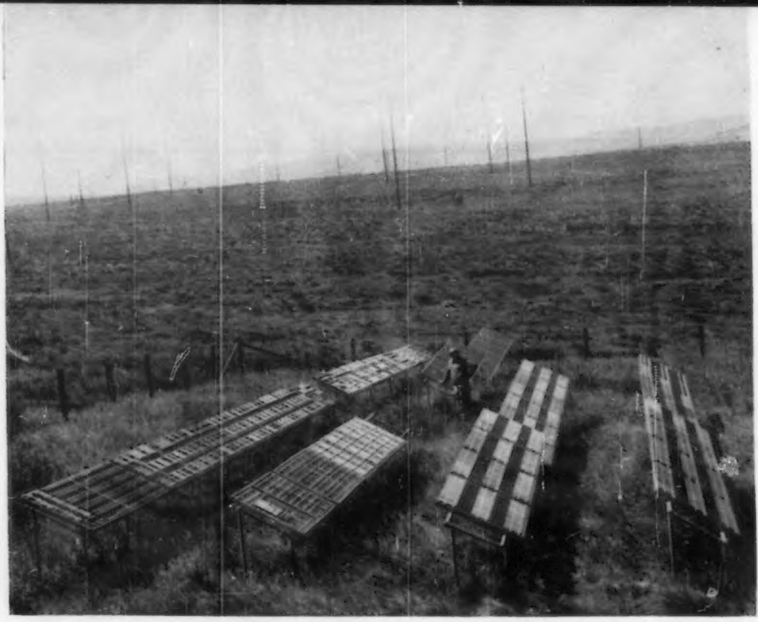
(From left to right) Frank Chairez, councilor from ASTM, secretary-treasurer; Paul G. Reeve, Hughes Tool Co., and councilor from the American Society of Mechanical Engineers, vice-president; Chris. A. Vogt, Consulting Engineer, and councilor from Texas Society of Professional Engineers, president; Maurice A. Riordan, of Rio Engineering Co. and councilor from National Association of Corrosion Engineers, outgoing president; and George Gibbs, Gulf Publishing Co., and councilor from the American Institute of Chemical Engineers, outgoing secretary-treasurer.

SOUTHWEST

Corrosion Committee Established

The Brazos River has long played a significant role in Texas history. On March 2, 1836, 58 Texas delegates met in Washington-on-the-Brazos to sign a declaration of national independence from Mexico. Today the river is the site of a growing community of industry.

One of the newest ASTM test sites is located on the Brazos River, just three quarters of a mile from the Gulf of Mexico and four miles down river from Freeport. The location was chosen to take advantage of the unique humidity conditions of the area where the daytime summer relative humidity lies in the range of 85 to 95 per cent, and winter days about 80 per cent. Evening humidity is usually about 100 per cent the year round. The climatic



Corrosion test site at Point Reyes, Calif.

situation makes this Gulf Coast area one of the most corrosive in the nation.

The Southwest District Council has just recently established a Special Corrosion Committee under the chairmanship of M. E. Holmberg, metallurgical consultant, to oversee the functioning and maintenance of the site. The special committee whose membership includes: Ed Hildebrand, Humble Oil & Refinery, Franz Vander Henst, NACE Headquarters, and Branch McNeely, International Nickel Co., will be able to assist setting up new projects at the site as well as lending its experience in assisting Gulf Coast corrosion studies.

At present, three significant exposure programs are under way at the Freeport Site. Committee A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys has a large program to obtain comprehensive data on performance of the corrosion characteristics of currently produced grades of stainless steel products. The specimens are stainless steel panels and coiled wire springs. Changes in tensile strength, fatigue strength, and appearance will be determined over an exposure period of 15 years.

The program of Committee B-7 on Light Metals and Alloys, Cast and Wrought includes 29 aluminum and 8 magnesium alloys in the form of sheet and panels, welded and riveted specimens, as well as sand and permanent mold castings. The latest data on this exposure program may be found in the 1958 Annual Report of Committee B-7.

The American Welding Society program at Freeport is intended to amass data from Gulf Coast corrosion effects on metallized specimens. It was felt that an atmospheric exposure program was necessary to provide sound technical information for the preparation of recommended practices for metallizing for corrosion resistance. To pursue this objective the AWS placed 28 varieties each of aluminum and zinc coatings on steel. Since porosity of metallized coatings is a limiting factor to their usefulness, half of these specimens have additional organic coatings in both single and double coats.

NORTHERN CALIFORNIA

Extensive Corrosion Test Program Progresses

On a remote wind-swept area jutting into the Pacific Ocean about 40 miles northwest of San Francisco, Calif., ASTM has placed its Point Reyes Test Site. Here specimens are subjected to salt spray and condensation exposure from the westerly winds and dense fogs which wet down the specimens most of the winter. During the summer the days are very dry and the nights are cool with frequent heavy fogs.

The Northern California District Council has appointed a special corrosion committee to act as the Society's contact, consisting of C. H. Fitzwilson, Columbia-Geneva Steel Division, U. S. Steel Co., chairman; S. Bianco, Bethlehem Pacific Coast Steel Corp.; L. J. Barker, Kaiser Aluminum and Chemical Corp.; and H. E. Thomas, Pacific Gas and Electric Co. The committee will act as the local contact for the site, assist in removal of specimens, oversee the maintenance, and maintain inventory of the site.

Four extensive corrosion test programs are being conducted at this site: Committee B-7 on Light Metals and Alloys has 29 aluminum and 8 magnesium alloys in a variety of forms which will be used to determine loss in tensile strength due to atmospheric corrosion.

Corrosion test site on the Brazos River near Freeport, Tex.

Committee B-3 on Corrosion of Non-Ferrous Metals and Alloys has exposed 70 commercially produced alloys of non-ferrous metals. These specimens will be subjected to loss in weight and strength tests and the measurement of corrosion pit depths over an exposure period of 20 years.

Committee A-7 on Malleable-Iron Castings is exposing malleable, pearlitic malleable, and nodular iron specimens. This is the largest and most comprehensive program in this field to date and is intended to provide data heretofore unavailable. The corrosion specimens will be exposed for periods up to 12 years.

A portion of the extensive program of zinc and aluminum metallized specimens of the American Welding Society is also located at Point Reyes. This test was designed to provide sound technical information for the preparation of recommended practices for metallizing for corrosion resistance.

The 1958 Annual Report of the Advisory Committee on Corrosion includes a bibliography of the reports of tests carried out at this and other ASTM test sites throughout the U. S.

Fourteen Districts Elect New Officers

Fourteen ASTM Districts have just completed their biennial election of officers. In addition, each district elected approximately one-half of their district council members, since it is the practice to have councilors serve for 2 years.

Among those taking office are:

Chicago: S. R. Wallace, U. S. Pipe and Foundry Co., chairman; K. R. Parker, Joslyn Manufacturing and Supply Co., vice-chairman; and C. S. Macnair, Acme Steel Co., secretary.

Cleveland: J. H. Lansing, castings consultant, chairman; A. G. Gray, *Metal Progress*, American Society for Metals, vice-chairman; and A. H. DuRose, Harshaw Chemical Co., secretary.

Detroit: Robert Sergeson, Jones & Laughlin Steel Corp., chairman; C. F. Nixon, General Motors Corp., vice-chairman; and C. E. Topping, Consumers Power Co., secretary.

New England: Randall H. Doughty, Fitchburg, Mass., chairman; E. F. Walsh, Narragansett Electric Co., vice-chairman; and W. L. Glowacki, Eastern Gas and Fuel Assn., secretary.

New York: A. A. Jones, Anaconda Wire and Cable Co., chairman; Lincoln T. Work, New York, N. Y., vice-chairman; E. R. Thomas, Consolidated Edison Company of New York, Inc., vice-chairman and E. J. Dunn, Jr., National Lead Co., secretary.

Northern California: R. W. Harrington, Clay Brick and Tile Assn., chairman; G. J. Grieve, Pacific Paint and Varnish Co., vice-chairman; and R. C. Vollmar, Standard Oil Co., secretary.

Ohio Valley: R. S. Armstrong, The Standard Oil Co., chairman; Archibald Hurtgen, Henry Vogt Machine Co., vice-chairman; and D. E. Krause, Gray Iron Research Institute, Inc., secretary.

Philadelphia: A. H. Kidder, Philadelphia Electric Co., chairman; H. W. Stuart, U. S. Pipe and Foundry Co., vice-chairman; and W. F. Bartoe, Rohm & Haas Co., secretary.

Pittsburgh: J. R. Remualdi, Carnegie Institute of Technology, chairman; E. J. Holcomb, Aluminum Company of America, vice-chairman; and A. S. Orr, Gulf Oil Corp., secretary.

St. Louis: W. C. Magruder, Carter Carburetor Co., chairman; A. M. Siegel, Industrial Research and Testing Laboratories, vice-chairman; and A. C. Weber, Laclede Steel Co., secretary.

Southern California: Byron P. Weintz, Consolidated Rock Products Co., chairman; R. E. Paine, Aluminum Company of America, vice-chairman; J. B. Howe, Maurseth & Howe, vice-chairman; and D. E. Bowers, General Petroleum Corp., secretary.

Southwest: E. E. Berkley, Anderson, Clayton and Co., chairman; R. C. Alden, Phillips Petroleum Co., vice-chairman; A. W. Eatman, Texas State Highway Dept., vice-chairman; Edwin Joyce, Dallas, Tex., vice-chairman; B. B. Manuel, W. H. Curtin and Co., Inc., vice-chairman; and Frank Chairez Eastern States Petroleum Co., Inc., secretary.

Washington, D. C.: Joseph E. Gray, National Crushed Stone Assn., Inc., chairman; Harold Allen, U. S. Department of Commerce, vice-chairman; A. B. Cornthwaite, Commonwealth of Virginia, vice-chairman; W. D. Poole, Bethlehem Steel Co., vice-chairman; C. E. Proudley, North Carolina State Highway of Public Works Commission, vice-chairman; and J. R. Dise, National Bureau of Standards, secretary.

Western New York-Ontario: C. L. Pope, Eastman Kodak Co., chairman; R. L. Terrill, Spencer Kellogg and Sons, Inc., vice-chairman; E. G. Baker, The Steel Company of Canada, Ltd., vice-chairman; and D. A. Hall, Eastman Kodak Co., secretary.

Applied Spectroscopy Symposia

A FEATURE of the Annual Meeting and Instrument Exposition of the Society for Applied Spectroscopy will be joint symposia on spectroscopy with ASTM Committee E-13 on Absorption Spectroscopy, November 5–7, 1958, in the Hotel New Yorker, New York, N. Y. ASTM Committee E-13 will also hold subcommittee meetings, including the organizational meeting of the subcommittee on Nuclear Magnetic Resonance.

A portion of the extensive program is given below:

November 5, 1958

ASTM Committee E-13 Advisory Board.

November 6, 1958

Symposium on Nuclear Magnetic Resonance.

Chairman: N. F. Chamberlain, Humble Oil and Refining Co., Baytown, Tex. ASTM Committee E-13, subcommittee and section meetings.

Session on Emission and Flame Spectroscopy.

Chairman: R. J. Carlo, Federated Metals Division, American Smelting and Petroleum Co., Barber, N. J.

Session on X-ray Spectroscopy.

Chairman: Sidney Kadamo, American Cyanamid Co., Bound Brook, N. J.

November 7, 1958

Session on Infrared Absorption Spectroscopy.

Chairman: W. C. Kenyon, Hercules Powder Research Center, Wilmington, Del.

Session on Ultraviolet Absorption Spectroscopy.

Chairman: R. H. Noble, The Peskin-Elmer Corp., Norwalk, Conn.

Symposium on Molecular Fluorescence Spectroscopy.

Chairman: R. L. Bowman, National Heart Institute, Bethesda, Md. Round Table on Molecular Fluorescence Spectroscopy.

Coming District Meetings

President Kenneth Woods will be the featured speaker at each of these meetings.

District	Date	City	Place
Southeast	October 6	Gainesville, Fla.	University of Florida
Southeast	October 8	Atlanta, Ga.	The Georgia Institute of Technology
Southeast	October 9	Knoxville, Tenn.	University of Tennessee
Ohio	October 10	Lexington, Ky.	University of Kentucky
New England	October 30	Boston, Mass.	Massachusetts Institute of Technology
Central New York	November 17	Troy, N. Y.	Rensselaer Polytechnic Institute
Philadelphia	November 20	Philadelphia, Pa.	Villanova University

Technical Committee Notes

At the annual meeting last June there were some 800 committee meetings. These are some of the things that were covered.

Metals

Steel

The basic oxygen process continues to be added to ASTM specifications for steel products. Tubular products, bar steels, and structurals are now permitted to be manufactured by the new steel making process. Subcommittees have approved the process for bar steel concrete reinforcement and for sheet steel and have referred the matter to **Committee A-1 on Steel.**

The concrete reinforcement subcommittee became very active in 1951 and the activity will continue through 1958 and 1959. The wire and wire fabric specifications are being revised to include a wire of 75,000 psi strength and also to include galvanized fabric. It appears that several new specifications will be established covering billet steel reinforcement of strengths above those presently in Specifications A 15 and A 408. Also being studied in terminology for reinforcement steel bars based on the yield strength rather than the present nondestructive terms of structural, intermediate, hard, rail, and axle.

Leaded steel appears to be deserving of some attention and work is being started to develop specifications for leaded steel forgings for flanges, fittings, valves and parts. Other new specifications under development cover carbon steel pressure vessel plate of improved transition temperature, case carburized chain, and welded chain for sprocket wheel application.

Very close attention is now being given to turbine and generator rotor forgings. The ASTM Specifications A 292 and A 293 covering these products are being extensively revised by changes in chemical composition, mechanical properties, and heat treatment. Additions to the specifications include impact test requirements, transition temperatures, ultrasonic inspection, and magnetic particle inspection. The Brittle Fracture Task Group has made considerable progress in regard to improving transition temperature and room temperature properties in production. The Hydrogen Task Group has decided to offer the Society a symposium on this subject.

Cast Iron

To meet the needs of an expanding field of application of nodular iron, **Committee A-3 on Cast Iron** has established a task group on nodular iron for valves and fittings.

Determination of carbon in cast iron and pig iron is somewhat difficult since much of it exists as graphite which is easily lost during sample preparation. A task group has made several recommendations to improve the reliability of analysis of pig and cast irons. Committee A-3 approved these recommendations which consisted of creating a task group in cooperation with Committee E-3 on Chemical Analysis of Metals.

An advisory committee has been appointed to serve as the American group on matters of international specifications for testing of cast iron. The international committee is known as ISO/TC 25 on Cast Iron.

As a result of more extensive testing of cast iron, interest has been growing in having a better and more economical test bar than now shown in Specification A 48. A task group on test bars is now obtaining data comparing results obtained with the current design and with new designs.

Magnetic Testing Methods for Weight of Zinc Coat

A preliminary report on the investigation of magnetic testing methods was presented at the meeting of **Committee A-5 on Corrosion of Iron and Steel.** In this program approximately 5000 magnetic flux measurements have been made by 15 individuals using 11 instruments of 4 different types on 15 sets of specimens of commercial hot-dip galvanized sheet varying in thickness from 0.36 to 1.64 oz per sq ft on the side tested. The general conclusion is that these instruments are satisfactory for the purpose and a detailed report on this study is being prepared for publication.

A new atmospheric exposure corrosion test program on testing hardware has begun at State College, Pa., and Kure Beach, N. C. This program includes a comprehensive set of hardware specimens made of carbon steel, four low alloy steels, and two nodular irons with hot-dipped, sprayed, and electro-deposited zinc, hot-dipped and sprayed aluminum, and in the bare condition.

Work on a specification for aluminized steel is under way following the presentation of the Methods of Test for Weight of Coatings on Aluminum Coated Iron and Steel. Two proposed specifications are in the draft stages, zinc-coated iron or steel sheets for culverts and underdrains and zinc-coated flat steel amoring tape.

Corrosion Resistant Steels

Two subcommittees of **Committee A-10 on Iron, Chromium, and Nickel Alloys** are working on the development of a specification for thin stainless steel sheets of 0.006 to 0.010 in. in thickness which are used primarily in aircraft. A test procedure will be established to accumulate data for specification limits.

Maximum carbon limits in low-carbon grades of stainless steel are being studied in detail. The object is to satisfy the producers from the standpoint of reasonable production procedures and to meet the demands of the chemical industry for corrosion resistance and the high-temperature interests for elevated temperature properties. This investigation will involve many ASTM groups as well as the ASME Boiler and Pressure Vessel Code, the American Welding Society, the Chemical Industry Advisory Board, and the American Iron and Steel Inst.

Progress is being made toward ASTM specifications for high-temperature superstrength alloys. Agreement has been reached that the alloys can be divided into four classifications—iron-base, cobalt-base, nickel-base, and stainless steel (precipitation hardening).

Uncommon Metals Studied—Zr, Cb, Mo, W, Li, U

Active task groups of **Committee B-2 on Non-Ferrous Metals** are working on tentative specifications for many of the uncommon or newer metals that are becoming important industrially such as zirconium, columbium, molybdenum, tungsten, lithium, and uranium. Fact finding groups are active on beryllium, tantalum, hafnium, and thorium, but no plans for specifications have yet been set definitely. It is probable that a symposium on these uncommon metals will be held at San Francisco in the fall of 1959 to assist in gathering information for specifications.

The deleterious effect of arsenic in solder when used to join copper and brass products was discussed at a meeting of Subcommittee III and steps are being taken to limit arsenic in

solder to a safe level when used in this field of application. A symposium on solders and soldering is being planned for 1961.

Work is in progress on tentative specifications for titanium and titanium alloy welding rod and bare electrodes, as well as on titanium and titanium alloy bars and billet.

Corrosion Study Expanded

Preliminary data, the final results of the program for determining the corrosiveness of various atmospheric test sites as measured by specimens of zinc and steel, was presented by **Committee B-3 on Corrosion of Non-Ferrous Metals and Alloys.** It was proposed that this study be expanded to include calibration of the test sites at Newark, N. J., Columbus, Ohio, East Chicago, Ill., and Freeport (Brazos River), Tex.

The 60 specimens each of 74 commercially produced non-ferrous metals and alloys are being placed at four test sites throughout the United States. The specimens have been analyzed for chemical composition, weighed, and thickness measured. When withdrawn following exposure the specimens will be measured to determine loss in weight and depth of pits. The specimens will then be cut into tension specimens to determine loss of strength.

The second progress report on measurement of atmospheric factors of corrosion of metals was presented. The data from this program are being analyzed to see if there is any correlation between the rate of corrosion and the factors of time-of-wetness, SO_2 concentration, and temperature.

A Getter That Really Gets

The bad effects of organic vapors on contact performance can practically be eliminated by using activated carbon wafers in the sealed enclosure, according to James R. Laskie of National Carbon Co., speaking before Subcommittee IV of **Committee B-4 on Metallic Materials for Electrical Heating, Electrical Resistance and Electrical Contacts.** Good activated carbon adsorbs about half its weight in organic vapors. A minimum of 0.6 g activated carbon per 10 cu in. of space is required.

The development of a method of bonding the carbon so as to be highly resistant to powdering from vibration while not reducing the ability of the carbon to adsorb has made possible the fabrication of small compact pellets which may be fastened where desired with epoxy cement. In some cases baking operations for outgassing have been eliminated by using this getter.

Reports on activity in 2000-a tests for arc erosion, on agreement as to method for static contact tests using crossed wires, and on results of microcontact tests at forces as low as 1 mg were given. Also tests of contact operation up to 186,000 times were reported, using the device recommended as tentative in the committee report. These data showed several cases of relatively high resistance which were self-correcting after some scores of operations. Resistances from 0.1 to 6 ohms occurred.

The work of a new Section H on Sliding Contacts will be of special interest in telemetering applications.

Technical Committee Notes

Test results were presented using a method for testing surety of make which is being readied for proposal as tentative. Statistical analysis comparing data indicates good agreement in average values for four laboratories with similar equipment, but standard deviations for three of these laboratories were smaller than consistent with the variation between means. This situation indicates some bias, such as differences in impact and slide in the various procedures, and the immediate task is to uncover these. Present results are good, but data in full conformance with statistical relations is hoped for. (Contributed by P. N. Bossart.)

Research on Die Castings

Committee B-6 on Die-Cast Metals and Alloys has several task groups working on developing quite significant data. One is concerned with the advisability of permitting a higher zinc content in the aluminum alloy SC84. Another is gathering data on the mechanical properties of zinc alloys cast in evacuated dies so that these can be compared with the regular die-casting process. Finally, progress is being made on the testing of 20-year atmospheric aged zinc and magnesium alloy die-cast specimens.

Moore and Gay Receive 1958 SES-ASTM Awards

Roger E. Gay, industrial executive, receives his certificate for "effective leadership in standardization in both industry and Government" from Herbert G. Arlt, president of the Standards Engineers Society and long-time ASTM member. E. P. Pitman, chairman of the New York District Council, presented Mr. Gay with his honorarium on behalf of ASTM.

Madhu S. Gokhale (left), chairman of the Standards Engineers Society special awards committee and former national president of SES, presents a certificate "for his pioneering writing and expression of philosophy applied to the practical everyday techniques of standardization" to Leo B. Moore, associate professor of industrial management at Massachusetts Institute of Technology. The Award is sponsored by ASTM and Russell P. Mahan, chairman of the Boston District Council of ASTM, is shown presenting Professor Moore with an honorarium in behalf of ASTM.

Construction Materials

Mortars

The requirements for a good mortar and grout for use in the construction of reinforced brick masonry structures will be covered in a proposed specification prepared by **Committee C-12 on Mortars for Unit Masonry.** This specification includes the qualifications of admixtures, mortar colors, and antifreeze compounds. After many years of use the Specification of Mortar for Reinforced Brick Masonry (C 161 T), first developed in 1941, has now been recommended for withdrawl as a result of newer specifications being accepted.

The research activities of the committee involve a cooperative test program on the study of a longer waiting period in the mixing of mortars and the water retention test, which will be run with other flow rates than now used.

Concrete Nuclear Shielding Study

The use of concrete in nuclear radiation shielding represents one of the newest subjects for consideration by **Committee C-9 on Concrete and Concrete Aggregates.** The requirements for concrete and concrete aggregate for this special use are now under consideration by a special *ad hoc* subcommittee which will make recommendations as to the work which the committee should be undertaking in this field.

A wide range of activity was reported by the various subcommittees with a few being mentioned at this time. The effectiveness of pozzolans against alkali aggregate will be analyzed by a proposed method of test. Two methods of test in draft form cover static modulus of rupture and creep of concrete.

The special problems involved in the testing of lightweight insulating concrete are recognized and a special task group is considering test methods for this purpose. A new tentative specification for cotton mats was approved, this being identical with the existing specification of the American Association of State Highway Officials. A new method of test for abrasion resistance of concrete-in-place is now being considered, following the acceptance of the method outlined in the 1958 Annual Report using the shot-blast apparatus. A complete review of the freezing-and-thawing test procedures is being made involving consideration of such items as the interruption of the cycle, an equation for modulus of elasticity, and a more closely defined time-temperature curve. The coverage of lightweight materials, as well as the minimum moisture content allowable for lightweight concrete, is receiving the attention of the subcommittee which developed the Specification for Packaged, Dry Combined Materials for Mortar and Concrete (C 387 T).

Cement

Masonry cement is receiving the combined attention of **Committees C-1 on Cement** and **C-12 on Mortars for Unit Masonry** as part of a joint investigation of mortars. This investigation is in progress with a study of mechanical mixing of pastes now completed involving test data from 214 laboratories on a masonry cement.

All cement specifications were reported under critical review with a number of changes accepted by Committee C-1. Portland blast-furnace slag cement (C 205) will now present a choice of eight types, based on general construction, air-entrainment, moderate sulfate resistance and moderate heat of hydration requirements. Information of low-alkali cements is provided as a note in specifications C 150 and C 175.

In respect to test methods, improvement in wet sieving processes for fineness has led to acceptance of a new method of test for fineness as measured by the No. 325 sieve. A new loss on ignition test for portland blast-furnace cement and for slag cement has been prepared.

The new basis for inspection of laboratories by the Cement Reference Laboratory is now in effect and has been well received, with considerable interest being shown in the expanded inspection service which now includes concrete testing laboratories.

Asbestos-Cement

A long-awaited specification for asbestos-cement nonpressure sewer pipe was approved by **Committee C-17 on Asbestos-Cement Products.** The specification covers this type of pipe for conveying sanitary sewerage in gravity-flow systems. There are five classes based on minimum crushing strength ranging from 1500 to 5000 lbs per ft, with size ranging from 6 to 36 in. The present Specification for Asbestos-Cement Pressure Pipe (C 296) was revised with the significant changes applying to the sections on manufacture and on inspection and rejection.

A revision of the existing ASTM Specification for Corrugated Asbestos-Cement Sheets (C 221) was also approved, this revision being for the purpose of including standards for lightweight corrugated sheets.

A comprehensive report was presented and discussed before the committee on the subject of radiation effects on structural materials. C. R. Norman, representing Committee C-17 on Committee E-10 on Radioisotopes and Radiation Effects, described radiation types and hazards, concrete shielding, definitions, and tables which, when read by the members, would provide them with an excellent background of the subject. Lime, asbestos, and gypsum, as specific materials used in radiation shielding, were discussed in greater detail.

Quicklime Specification Being Revised After 32 Years

The requirements for building lime, one of the oldest of the building materials, need to be examined from time to time in spite of the heritage of hundreds of years of use. The Specification for Quicklime for Structural Purposes (C 5) is now being revised by **Committee C-7 on Lime** after a period of 32 years without change. For years it has been required to soak quicklime for a two-week period before use to avoid unburned and unhydrated particles from appearing in the construction. With the advent of fine pulverizing, it is now possible to soak the lime and store it only until cool before use. The committee will now revise this long-standing requirement accordingly. The use of a blended sand instead of a graded sand in the water retention test procedure, as found in ASTM Method C 110, was approved, which will result in a change in the water retention requirement amounting to an increase of 5 per cent.

The use of pozzolanic materials with lime will now be covered in a specification which will be resubmitted to the committee following the review of negative comments. In this connection a round robin test program to evaluate the chemical and physical reactions to pozzolanic materials will be undertaken.

An addition of the group of specifications of lime for use in chemical industries is a proposed specification for quicklime for hypochlorite bleach manufacture which was accepted for further letter ballot following the review of negative comments.

Technical Committee Notes

Clay Pipe

The expansion of use of high-strength clay sewer pipe with longer lengths has led to the need and development of better types of joints. **Committee C-4 on Clay Pipe** will request authorization from the Board of Directors to expand its scope to include joints as well as clay liner plates. New specifications have been prepared for letter ballot of the committee covering both clay liners and factory-made joints for clay sewer pipe.

The use of larger, as well as longer length, pipe has raised problems in the testing of this pipe which the committee has realized, and research is planned to determine whether the existing testing apparatus is satisfactory, particularly as to whether the upper beam in the breaking strength test apparatus has the proper rigidity, cross-section, etc., to handle the longer pipe in the large sizes. Comparative data will be collected on crushing tests of full-length pipe and short ring sections to establish the feasibility of testing the short section in lieu of the full-length pipe.

New Test for Water Retardent Silicones

Reflecting the current demand for test methods which will give an indication of the condition of concrete masonry units and the potentiality for volume change in exposure to atmospheric conditions, a new method of test for determining the moisture condition of hardened concrete by the relative humidity methods was approved by **Committee C-15 on Manufactured Masonry Units.** With the use of this method, which will establish a sound basis for indicating and limiting the moisture condition of concrete masonry units, it is expected that practical relative humidity limits can be incorporated into specifications. A proposed method for determining dry shrinkage of concrete masonry units, based on the modified British method, was also accepted by the committee subject to letter ballot. This method is felt to be equally important in evaluating the various factors involved in concrete masonry construction.

A proposed method of test for measuring the effectiveness of transparent water-retardent materials is being subjected to a round-robin test series in which three silicone materials are being tested in three laboratories, and good progress is reported. A new project which will get under way is that of developing a test method to cover cement-base paints.

A proposed specification for chemical-resistant ceramic tower packings is now reported as being 70 per cent completed. This development has been a very difficult one due to a number of factors involved which are critical in the performance of these units. A draft of a revision of the Specification for Clay Drain Tile (C 4) is now being circulated for subcommittee consideration with the subcommittee planning to meet late in the year for final review.

Bituminous Materials

Bituminous materials have been used as the basic material in a number of products used in connection with building construction but without full coverage by ASTM standards. **Committee D-8 on Bituminous Waterproofing and Roofing Materials,** now in its fifty-third year, has expanded its scope of activity to include additional products. Its title and scope will now encompass bituminous materials for roofing, waterproofing, and related building and industrial uses.

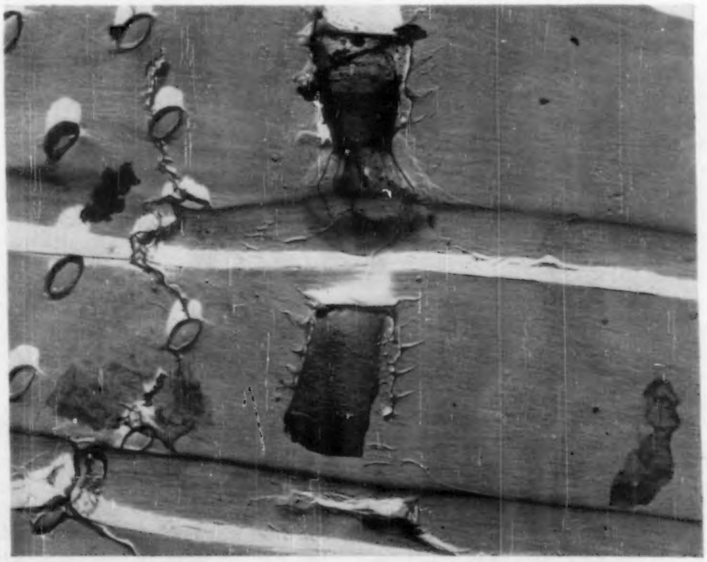
The development of ASTM standards on bituminized fiber pipe represents the first activity in this expanded field. A new subcommittee held its first full meeting, organizing four task groups which will cover dimensions, physical tests, chemical tests, and an outline of the types of specifications needed.

A second new subcommittee was authorized to develop standards in the field of industrial pitches.

Tests to Aid Design of Bituminous Paving Mixtures

With the spotlight focused on stripping of bituminous-coated aggregate mixtures as a result of the symposium presented at this Annual Meeting, special attention was given by **Committee D-4 on Road and Paving Materials,** to a new draft of a proposed method of test for coating and stripping of bituminized aggregate mixtures. The new draft was approved for letter ballot of the committee following further editorial review. Task groups are considering other types of analysis, such as a method involving the lithium salt flame photometer. They are also looking into specific correlation of service performance and laboratory tests.

An equally active field of activity in the committee is in the development and use of test methods leading toward the design of bituminous pavement mixtures. With the approval at this meeting of several test methods relating to deformation, cohesion, and resistance to plastic flow of bituminous mixtures, desire was expressed to prepare a manual for a recommended practice for the design of bituminous mixtures using the accepted ASTM methods as



Fungal Hypha in the Wall of a Basswood Vessel Segment

First Prize, Student Entry, Electron Microscope—Eleventh ASTM Photographic Exhibit. Wilfred A. Côté, Jr., Department of Wood Technology, State University of New York, College of Forestry, Syracuse, N. Y.

the basis. Preliminary to this, a symposium on methods of test for the design of bituminous paving mixtures is now planned for the 1959 Annual Meeting. In the extraction and recovery of constituents of bituminous mixtures, four study groups have been conducting cooperative work using the Maryland and Immer extractors. Satisfactory agreement has been found between these laboratory methods and field methods. However, a new procedure is being studied for later consideration. Setting qualities of bituminous materials continue to receive attention, with additional cooperative tests planned to augment existing information. These tests will involve the rolling ball test procedure with five laboratories participating. Cooperative tests have been conducted on emulsions to obtain data with which an attempt will be made to improve the reproducibility and the repeatability of test method D 244.

Four methods pertaining to soil-cement mixtures, under the joint jurisdiction of Committees D-4 and D-18 (Soils), were approved subject to letter ballot. The methods involve the making and curing of soil-cement compression and flexure test specimens in the laboratory, compressive strength of molded soil-cement cylinders, compressive strength of soil-cement using portions of beams broken in flexure, and flexural strength of soil-cement using a simple beam with third-point loading.

Soils

The development of standard methods of test for soils is being approached on a broad front by **Committee D-18 on Soils for Engineering Purposes.** A draft of a method of sampling by use of the diamond core drill was reviewed. Moisture content and density of soils are important factors, and the several test methods now published will be revised as a result of committee consideration. Under the category of structural properties, a proposed method of determining unconfined compression is in its first draft form.

There are a number of classification systems now recognized and in use. The group interested in this phase is making a concerted effort to reconcile the various systems and to establish a standard which would be recognized as a national classification system.

In line with the committee's objective of contributing to engineering knowledge of soils, which has resulted in an imposing series of symposia sponsored by the committee, two new symposia are being planned for the 1959 Annual Meeting, one to cover the rate of loading as applied to soil tests, and the other, Atterberg limit tests.

Organic Materials—Chemical Products

Exposure Tests for Concrete Panels

Committee D-1 on Paint, Varnish and Lacquer and eighty of its subcommittees and working groups held meetings over a three-day period during the Annual Meeting. Consideration is being given by a new task group to two types of concrete panels for outdoor exposure tests and one type for artificial weathering tests. The new Subcommittee on Statistical Application has organized working groups on experimental design of cooperative tests, interpretation and presentation of cooperative test data, and precision of test methods.

The Subcommittee on Latex and Emulsion Paints has completed its first test procedures which include a method for fluorescence and a test for package stability. Cooperative laboratory test studies are continuing on washability and scrubability, on freezing-and-thawing stability, and coalescence. Studies are also being made of tests for exterior latex paints.

Resin Softening Point Test

The thermometer drop method of determining the softening point of rosin was reviewed by **Committee D-17 on Naval Stores.** In this test a prescribed amount of rosin molded onto the bulb of a specially designed thermometer drops off when the temperature of the medium in which it is immersed is raised above the softening point. A study was proposed to standardize such a method for presentation at the next meeting.

A report covering the relative tendency to crystallize from solution of some 46 gum rosins was presented. This study utilized samples which were representative of the entire output of the gum naval stores industry and production throughout the regular operating seasons.

Further collaborative work is being undertaken to improve the Linder-Persson method for determining fatty acids in tall oil rosin which was proposed as tentative in the Annual Report.

Styrene Monomer Specification Planned

A program to develop specifications for styrene has been initiated for which about 10 test methods will be needed. The first five to be started immediately are polymer content, polymer solubilty, viscosity, inhibitor, and color. A new method which will be presented to the committee at the next meeting will be the determination of xylene isomers by infrared absorption spectroscopy. A cooperative program to develop a standard method of detecting trace amounts of chlorine and sulfur has been started.

Nearing completion are methods for the determination of water content of refined phenol by the Karl Fischer method, determination of color of refined phenol, and determination of traces of thiophene in benzene by the isatin method.

Two new groups were formed—American Group on ISO 78 on Aromatic Hydrocarbons, and a subcommittee on Phthalic Anhydride.

These activities highlighted the meetings of **Committee D-16 on Industrial Aromatic Hydrocarbons.**

First Urethane Foam Standards

Two new tentatives covering cellular products were presented to the Society by **Committee D-11 on Rubber and Rubber-Like Materials.** Prepared in cooperation with the Society of the Plastic Industry, they cover methods of test for flexible urethane foam and specifications and methods of test for flexible foams made from polymers and copolymers of vinyl chloride.

Another important recommendation in the report this year was the methods for chemical analysis for natural rubber. This represents a revision and considerable enlargement of the present Tentative Methods D 1278. The revised methods now include procedures for sampling, volatile matter, dirt, ash, copper, manganese, iron, acetone extract, and rubber hydrocarbon.

A new ultrasonic method for adhesive bond, such as used in automotive brake lining and other friction materials, was presented for committee letter ballot as a new tentative.

In cooperation with Committee D-13 on Textile Materials, work is being undertaken on development of test methods for rubber-coated tire cords. The textile committee will concern itself with the measurement of cord properties and Committee D-11 will develop methods for measuring the adhesion to rubber of textiles. This will also include preparation of methods for analysis of rubber coating on tire cord.

A new tentative method of test for abrasion resistance of rubber soles and heels was presented for committee letter ballot. This method is intended for determining the resistance to abrasion of rubber compound used in the soles

Technical Committee Notes

and heels of rubber footwear. The method uses the National Bureau of Standards abrasion machine.

At a dinner on Thursday, June 26, the committee honored O. M. Hayden on the occasion of his retirement from E. I. du Pont de Nemours & Co., Inc. Mr. Hayden has been an active member of the committee since 1931 and served as chairman from 1936 to 1942. In 1954 he received the ASTM Award of Merit.

Symposium on Fuel Oil, Lube-Oil Study . . . Highlight Varied Program

Apart from the annual report of **Committee D-2 on Petroleum Products and Lubricants,** which comprised 140 pages, the tremendous activity of this committee was indicated by the 119 meetings of its research divisions, technical committees and subcommittees during the six days of the Annual Meeting.

Of the eight proposed tentatives in its preprinted report, the committee withdrew one—the proposed Tentative Method of Test for Oxidation Resistance of Paraffin Wax. The committee also withdrew the recommendation for immediate revision of the Standard Method of Test for Distillation of Gasoline, Kerosine, Naphtha, and Similar Petroleum Products (D 86–56); also the proposal for revision and reversion to tentative of the Test for Distillation of Gas Oil and Similar Distillate Fuel Oils (D 158–54).

The Study Group on Nuclear Problems made plans for sponsoring a Symposium on Radiation Problems and Technology in the field of petroleum products, to be held during the next meeting of the committee in Washington, D. C., on October 5 to 9, 1958.

A Symposium on Hydraulic Fluids is being planned for the Third Pacific Area National Meeting of the Society to be held in San Francisco in October, 1959. The papers comprising this Symposium will be devoted to two subdivisions, one relating to physical and chemical properties and the other to functional evaluation of hydraulic fluids.

One of the highlights of the D-2 meeting in Boston was a Symposium on Stability of Distillate Fuel Oils. The Symposium comprised nine papers and was sponsored by Technical Committee E on Burner Fuel Oils. The subjects covered by the nine papers were as follows:

"Burning Today's Fuel Oils," by G. T. Kaufman, Iron Fireman Manufacturing Co., Cleveland, Ohio.

"Trials and Tribulations of a Large Development Oil Heating," by N. M. Edmands, Meenan Oil Co., Inc., Levittown, N. Y.

"Predictive Type Tests for Storage Stability and Compatibility of Diesel Fuels," by R. T. Jones and J. W. MacDonald, Fuels and Lubricants Division, United States Naval Engineering Experiment Station, Annapolis, Md.

"Requirements for Dependable Performance of Domestic Oil Burner Nozzles," by

ASTM STANDARDS AT WORK

ASTM Helps Realize a Dream

THE DREAM of uniting by highway the two peninsulas which form the state of Michigan is an accomplished fact now that the Mackinac Straits Bridge has been completed.

The structure spans the Straits of Mackinac from Mackinaw City to St. Ignace on the upper peninusla. It is the world's largest suspension bridge, measuring 8614 ft from anchor block to anchor block. The entire bridge, including approaches, is 26,444 ft in length.

Officially opened to traffic on Nov. 1, 1957, the bridge cost about $100,000,000 and required the concentrated engineering talents of Merritt-Chapman & Scott Corp., the American Bridge Division and American Steel and Wire Division of United States Steel Corp., and David B. Steinman, Consulting Engineers and Designers.

Some 26 ASTM standards were used to specify materials in this new link in American highways. Among those used to specify steel and steel products were A 7, A 27, A 94, A 141, A 194, A 235, A 237, A 325, A 354, and A 48.

Standards applicable to the concrete and associated products included A 15, A 305, C 33, C 150, C 175, C 260, C 330, D 544, and D 1190. Standards used for materials for the electrical systems included A 72, A 252, B 8, B 152, D 27, and D 120. Construction lumber, in part, was designated by Standard D 245.

Construction Box Score

Total length of bridge with approaches, ft	26 444
Length of main span (between towers), ft	3 800
Heights of main towers above water, ft	552
Height of roadway above water at midspan, ft	199
Total length of wire in main cables, mile	42 000
Maximum tension in each cable, ton	16 000
Number of wires in each cable	12 580
Total concrete in bridge, cu yd	466 300
Total weight of bridge, ton	1 024 500
Total number of steel rivets	4 851 700
Total number of steel bolts	1 016 600
Total number of blueprints	85 000

E. O. Olson, Delavan Manufacturing Co., West Des Moines, Iowa.

"Do We Need a Stability Specification for No. 2 Heating Oil?" by Robert Gray, Editor, *Fuel Oil and Oil Heat*, New York, N. Y.

"A Review of the Distillate Fuel Stability Problems," by E. A. Elmquist, Fuel Oil Applications Engineer, Shell Oil Co., New York, N. Y.

"How Distillate Fuel Stability Is Measured and Controlled," by W. L. Clinkenbeard, Process Research Division, Esso Research and Engineering Co., Linden, N. J.

"Distillate Fuel Incompatibility," by C. C. Ward and F. G. Schwartz, Branch of Chemistry and Refining, Bureau of Mines, Bartlesville, Okla.

"Distillate Fuel Oil Gel," by F. R. Dunn, Jr., and R. W. Sauer, Research and Development Department, Atlantic Refining Co., Philadelphia, Pa.

Consideration is being given to publishing these papers as a *Special Technical Publication.*

Consideration was given to organizing under Technical Committee B on Lubricating Oils separate groups, one on automotive lubricants and the other on industrial lubricants possibly with the cooperation of other organizations, such as the Society of Automotive Engineers and American Society of Lubrication Engineers. This would result in broader consumer representation. A very timely report on studies made by a study group on the application of crankcase oils presented the results of an extensive review of procedures and data from both automotive research laboratories and end-product divisions on a single cylinder and full scale engine testing data secured under several operating conditions. Based on these data the study group proposed three test procedures intended to define the minimum performance requirements of oils classified for service MS for use with automotive gasoline-powered engines, including the 1958 models. Service MS represents "most severe service" encountered in the operation of gasoline-burning engines and the procedures were carefully screened from this point of view. It is believed that this study represents a big step forward and should further the communication between automotive engineers and petroleum technologists—preferably communication in the form of quantitative and significant statements of automotive requirements.

There were 13 proposed methods submitted by Committee D-2 for publication as information. Perhaps the most significant of these was the proposed method of test for Knock Characteristics of Motor Fuels Above 100 Octane Number by the Research Method. A similar proposed method is in preparation by the committee for the Motor Method. Included among the proposed methods were tests for filterability of aviation turbine fuels, particulate matter in hydrocarbons, test for sealing strength and breaking strength of waxes, ash content of petroleum oils, and maximum fluidity temperature of residual fuel oil.

At the D-2 Annual Dinner the guest of honor was Stewart S. Kurtz, Jr., of Sun Oil Co. Mr. Kurtz has been a member of Committee D-2 for the past fifteen years. He is chairman of a number of sections and of the Coordinating Division on Nomenclature and has been most active on many other D-2 research divisions and technical committees. In 1954 Mr. Kurtz received the ASTM Award of Merit on the recommendation of Committee D-2.

Coal and Coke

Procedures for the determination of sulfur in ash and the determination of mineral carbonate in coal were given final review prior to submission to subcommittee letter ballot by **Committee D-5 on Coal and Coke.** The first draft of a method for mechanically sampling continuous coal streams was prepared for subcommittee action. The proposed Method of Test for Expansion Properties of Coal for Use in By-Product Coke Ovens by Means of the Bethlehem Test Oven and the proposed Method for Measurement of Pressures Developed During Carbonization of Coal by the Russell Movable Wall Oven which were published as information only in the Committee D-5, 1943 Annual Report, were referred to a subcommittee for preparation as standards.

Messers O. W. Rees, R. F. Abernethy, C. C. Russell, and C. R. Montgomery were the U. S. delegates to the ISO/TC 27 on Solid Mineral Fuels meeting in Harrowgate, England, of June, 1958. (See story, ASTM BULLETIN, July, page 53) O. W. Rees reported that the American delegation would have the opportunity to present draft proposals of procedures for the use of an adiabatic calorimeter and the Gieseler plastometer at the next ISO meeting.

Analysis and Testing

Methods of Testing

Committee E-1 on Methods of Testing added to its preprinted report additional revisions in the Standard Specifications for ASTM Thermometers (E1-57). These revisions affect the dimensioning of the thermometers and are similar to the proposed changes in the precision thermometer specifications which appear in the 1958 annual report as preprinted. The proposed changes were presented subject to approval by other technical committees of the Society interested in the particular thermometers. Consideration was given to these revisions by these committees during the Annual Meeting in Boston and it is expected that favorable action has been taken so that these additional changes can be included in the 1958 Book of ASTM Standards.

Committee E-1 submitted to the Society at the Annual Meeting new Standard Specifications for Distillation Equipment (E 133 – 58) covering such types of laboratory distillation equipment as distillation flasks, condenser and cooling baths, heat sources, glass support, metal shield and enclosure for flasks and graduated cylinders. These specifications and the new Tentative Specifications for Pensky-Martens Closed Flash Tester (E 134 – 58 T) represent two important additions to the several ASTM standards covering laboratory apparatus.

An extensive revision of the Tentative Methods of Test for Brinell Hardness of Metallic Materials (E 10 – 54 T) was completed at the meeting. The revised methods will be submitted to the Society through the Administrative Committee on Standards for publication this year.

Standard Analysis for Zr, Cb, Li Being Developed

Solvent extraction in the analysis of metals was covered in the symposium sponsored by **Committee E-3 on Chemical Analysis of Metals.** Principles of solvent extraction and some of the newer complexing reagents which make possible additional determinations by the solvent extraction technique were covered. This symposium is discussed in more detail elsewhere in this issue.

Among the new and revised methods submitted to the Society was the first of a series of methods being developed for the chemical analysis of fire-refined copper.

Work was begun on methods of analysis of several metals not now covered by ASTM methods—zirconium, columbium, lithium, and metal powders.

Fatigue Survey Completed

Committee E-9 on Fatigue at its recent meeting in Boston announced completion of a survey on current and anticipated research activities in the field of fatigue.

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In 1957, the committee circulated a questionnaire concerning such activities to universities, research institutes, and government and industrial laboratories known to be interested in the field. Replies received over the past eleven months were analyzed and tabulated and will be published by the Society in the near future.

The committee feels that this information will prove valuable in eliminating duplication of effort and in acquainting various groups with the laboratories conducting research in given areas.

The highlight of the meeting was an illustrated talk on low-cycle, plastic strain fatigue by L. F. Coffin of the General Electric Co. Mr. Coffin pointed out that under thermal shock situations such as pressure vessels, where the component does not undergo a large number of fatigue cycles, this type of data is essential.

Building Constructions

The preparation of a proposed method of test for bond strength of mortar to masonry units is an example of one of the many facets of building construction with which **Committee E-6 on Methods of Testing Building Constructions** is concerned at the present time. This property of mortar plays an important part in the service of masonry walls involving masonry units bonded together with mortar. Such properties as the initial flow, water retention, air content, and compressive strength of the mortar are determined as part of the procedure leading up to tests on assemblies of masonry units.

The committee-sponsored Symposium on Durability attracted a good audience and the papers presented provoked very useful discussion. As a result of the presentation of the symposium papers, the committee has agreed on the principle that moisture liquid and moisture vapor movement through materials or constructions must be kept below a threshold amount if condensation and soluble salt effects are to become negligible.

A wet racking test procedure has been prepared which will be circulated with data as a proposed additional test to Methods of Conducting Strength Tests of Panels for Building Construction (E 72). Three methods of making lateral nail tests of sheathing materials will be studied for the purpose of selecting a single method. A review of the firts draft of a proposed Method of Testing Wooden Trussed Rafter Assemblies indicated that the method was too restrictive in several respects and a new draft will be prepared.

Evaluation of Spectrophotometers

Proposed methods for evaluation of spectrophotometers, for publication as information only, were submitted to the Society by **Committee E-13 on Absorption Spectroscopy.** These methods will provide a means for determining suitability of spectrophotometers in test methods employing absorption spectroscopy, on the basis of the important characteristic of the apparatus.

High-Temperature Properties of Cast Iron Investigated

A final report of an investigation on the properties of cast iron in the temperature range of 800 to 1000 F was presented to the **ASTM-ASME Joint Committee on Effect of Temperature on the Properties of Metals.** The report was presented by J. R. Kattus of the Southern Research Inst., Birmingham, Ala., under whose direction the project was conducted.

The purpose of the investigation, which was begun in 1953, was to determine whether low-alloy cast irons can safely be used for load-carrying application above the presently specified maximum of 650 F. The properties of six commercial low-alloy gray cast irons and of one unalloyed ferritic nodular iron were evaluated at 800 and 1000 F by means of tension, creep-rupture, thermal shock, and growth tests. Metallographic examinations were also made. Results of these tests for the various alloys are given in the complete report which will be published by ASTM as a *Special Technical Publication.*

Nondestructive Testing

Reference radiographs of heavy-walled steel castings for the use of industry in establishing quality limits of defects in these products are being considered by **Committee E-7 on Nondestructive Testing.** Suitable castings purchased from foundries would be used as a basis for these radiographs. To cover the cost of these castings it was proposed to approach the Steel Founders Society, the Manufacturers Standardization Society of the Valve and Fittings Industry, and the ASTM Administrative Committee on Research. Also being planned is a program to improve the present set of reference radiographs for aluminum and magnesium castings.

A subcommittee on electromagnetic (eddy current) tests is being organized. At an organization meeting on June 26, it was agreed to concentrate on test methods for nonmagnetic metal tubing. Also a task group will be formed to investigate the need for similar testing of ferromagnetic tubing.

Papers to Appear in Future Issues of the ASTM BULLETIN

The Successive Determination of Manganese, Sodium, and Potassium in Cement by Flame Photometry—C. L. Ford, Portland Cement Assn.

A Note on the Pressurization on the Fatigue Life of Metals—L. W. Hu, The Pennsylvania State University.

Mechanical Behavior of Fiberglass Reinforced Laminates—F. J. McGarry and R. E. Chambers, Massachusetts Institute of Technology.

False Negative Permanent Strains Observed with Resistance Wire Strain Gages—C. J. Newton, National Bureau of Standards.

Measurement of Bulk Modulus of Hydraulic Fluids—R. L. Peeler and J. Green, California Research Corp.

A Method of Test for Potential Efflorescence of Masonry Mortar—P. O. Rogers, Riverton Lime and Stone Co.

Tension Testing of Rubber Rings—F. L. Roth and R. D. Stiehler, National Bureau of Standards.

Thermal Stability of Glasses in ASTM Thermometers—E. L. Ruh and G. E. Conklin, Esso Research and Engineering Co.

Quick Experimental Determination of the Optimum Activation Conditions of Clays for Their Transformation into Artificial Pozzolans—A. L. Ruiz, Rota Laboratories, Spain.

Beam and Column Tests of Welded Steel Tubing with Design Recommendations—D. S. Wolford, Armco Steel Corp.

Separation of Oil from Lubricating Greases in Storage—Report of Section IV, Technical Committee G of Committee D-2 on Petroleum Products and Lubricants.

Evaluating the Slip Resistance of Floor Waxes

The Significance of Friction Measurements

In the February, 1954, ASTM Bulletin, Committee D-21 on Wax Polishes and Related Materials published methods for determining the static and dynamic coefficient of friction of waxed floor surfaces under controlled laboratory conditions. After a number of years' experience with the James and Sigler machines, the committee presents this discussion of the capabilities, field of usefulness of such tests, and the areas in which they may not justifiably be applied.

This summary generally reflects the opinion of the group actively engaged in this work at present. It has been prepared by a task group of Subcommittee IV, ASTM Committee D-21 consisting of B. S. Johnson, C. S. Kimball, J. V. Steinle, C. L. Weirich, and F. J. Wolter.

Machines Used for Measuring Coefficient of Friction

James Machine

The James machine measures static coefficient of friction, using a leather sole with a low pressure per unit of area. The action of the machine has been loosely described as an attempt to simulate conditions under the sole of the foot during the middle and latter portions of a stride. Since the sole is of leather—the material used in the majority of shoe soles—the results should correlate with actual slip resistance provided the shoe sole is of identical surface character and is smooth, clean, dry, and free from wax or other extraneous material. In actual practice this condition is quite rare. The grade of sandpaper used to smooth the experimental sole on the James machine, for example, affects the coefficient of friction readings. Since the soles of shoes in service differ in roughness, cleanliness, etc., complete correlation between the machine and foot tests should not be expected.

Coefficient of friction as discussed here is not a characteristic of *one* material. It must always be measured as a resultant of three different materials—the shoe used, the wax, and the substrate. The flooring material itself makes a tremendous difference in overall slip resistance. Waxes completely safe on one type of flooring may be hazardous on another. For that reason, correlation between foot tests on the floor and readings on the machine should not be expected unless the three materials are identical. No correlation can be expected between field test results with neolite and rubber soled shoes when compared with the readings obtained with an experimental leather sole on the James machine.

Sigler Machine

The Sigler machine is a dynamic impact type of tester which measures coefficient of friction. Supposedly it simulates heel impact conditions. The remarks above regarding rubber soles on the James machine apply equally well to the leather heels of the Sigler machine. One additional factor present in the Sigler machine is the necessity of carefully controlling the *compressibility* of the leather used in making the experimental heel. If this is not controlled, results will vary considerably.

It must be emphasized that both of these methods of test are of a low order of precision. Numerical differences in the second digit may not be significant, particularly where numerical results are high.

Coefficient of Friction Tests *versus* Floor Safety

There are presently no standards of floor safety that can be expressed in terms of accident frequency, coefficient of friction, or subjective foot tests in the field. What may be a lower than average accident frequency can very well be due to factors other than the slip resistance of the floor wax used. Conversely, higher than average frequency rates may not at all be due to the character of the floor wax used.

It is now generally accepted by those engaged in this study that machine measurements of the coefficient of friction cannot be expected to correlate in all cases with foot tests on the floor or with safety in use. Some observers report that foot tests in the field are more sensitive than either the James or Sigler test. Where machines have rated waxes as of identical coefficient of friction, some field tests have shown very significant differences.

There are many other factors not determinable by laboratory machine testing which contribute substantially to slips and falls. There are a dozen or more common factors which influence accident rates. Many of these contribute substantially more than do the differences in the coefficient of friction to the incidence of slips and falls. The most substantial contribution to accidents is made by loose litter, water, etc., on the floor. Statistics have shown that the chief cause of falls in hospitals have been leaves and flowers brought into patients' rooms. The physical condition of the floor is very important. The individual himself contributes to the incidence of accidents by physical idiosyncrasies, such as his method of walking and distribution of forces during walking. The psychological aspect has to be considered. Experimental work indicates that most people assume unconsciously that a glossy floor is slippery and change their stride accordingly. On the other hand, when blindfolded they made no change in their stride when encountering a glossy floor, as they did when they were not blindfolded.

This brief statement summarizes, perhaps by oversimplification, the general thinking of those familiar with the rating of floors for safety in use. A conclusive test of comparative floor safety can only be made by prolonged observations under conditions prevailing at the place of use. The translation of laboratory coefficient of friction into an estimate of comparative safety is not always justified by experience.

The Utility of Coefficient of Friction Data

The laboratory machines are of value to the wax formulator, particularly for screening new formulations where the composition is known to the operator.

One insurance company states that by using the Sigler machine and demanding a minimum coefficient of friction they have substantially decreased the incidence of slip accidents. However, this company uses the machine on the floor itself and not in accordance with published ASTM directions. The mere fact of having directed attention to the hazard may be a factor.

Some agencies have set a minimum coefficient of friction for acceptability of floor waxes. Under the conditions of use, this does make some rough separation of waxes at a marginal level.

Testing and Engineering of Military Textiles

By STEPHEN J. KENNEDY[1]

This address, presented* in acknowledgment of the Harold DeWitt Smith Award, reports the development of the Stoll-Quartermaster Universal Abrasion Tester, a laboratory instrument which has contributed greatly to the engineering of military textiles.

FIRST let me say how deeply I appreciate the honor you have done me by the award of the Harold DeWitt Smith Memorial Medal.

I feel very humble in accepting this award when I think of my many co-workers in our Quartermaster Textile Research & Engineering Laboratories whom I feel in a real sense I am representing here today, and whose many contributions in this field I feel are also being honored in this award.

The establishment of the Harold DeWitt Smith Award has seemed to me to be a very fitting act. In the many contacts I had with Dr. Smith during World War II when he served very generously as a consultant to the Office of The Quartermaster General, I was always deeply impressed by his selflessness, and the singleness of his devotion to the needs of his country. In the War Department Certificate of Appreciation awarded to Dr. Smith by the Secretary of War in 1946 in recognition of his assistance to our office, reference was made to the repeated occasions during World War II when Dr. Smith "made available his wide scientific and technical knowledge in the field of textiles for the solution of Quartermaster problems, particularly in his work on the study of causes of degradation of protective clothing and his leadership in research and development on Quartermaster fabrics for clothing and equipping soldiers."

We in the Quartermaster Corps have been doubly blessed in having had the opportunity of working with Dr. Smith, as well as having had the benefit of his advice and critical evaluation on some of our problems in military textiles.

It is most appropriate too that Committee D-13 should be the sponsor of an award to commemorate the memory of a man who more than anyone else in our generation has focused the eyes of our industry upon the capability of creating from textiles, true engineering materials. For Committee D-13, more than any other organization in the textile industry, has stood for the introduction of the tools of engineering progress in textiles.

Textile research could never have gotten started had not people like those in Committee D-13 concerned themselves about the development of test methods by which people could measure the properties of textile materials. The progress of textile research has similarly been dependent in no small degree upon the widening development of tools to define the performance of textile materials in respect to use requirements.

Test method development has contributed greatly to the engineering of textiles, especially in certain areas of direct interest to the military services as consumers. I think that one of the most instructive subjects for this purpose would be to look at the engineering of textile materials to increase their service life.

Essential Problems Defined Early

At the Symposium on Test Methods held during the Fall meeting of Committee D-13 on Textile Materials in 1937, Professor Ball of Lowell Technological Inst., presented a most interesting paper on "Abrasion and Wear Testing Machines for Textiles" (1). In this paper, he reviewed the essential features of some eleven textile abrasion or wear testing machines which at that time were in use in this country and abroad.[2]

One of the interesting things about Professor Ball's review, which I believe was characteristic of most of the thinking in this area at that time, was the concern about how laboratory wear tests might be related to actual service use and what methods of measurement might be applied for rating serviceability.

Although the essential problems were quite well defined at that time, there was no accepted basis for selecting between the competing claims of the different approaches to laboratory wear testing.

When World War II broke out the focus upon meeting the needs of our forces in the most extreme climates of the world—jungles, deserts and the Arctic—required primary interest being placed upon the designing and providing of equipment as quickly as possible. The study of materials could not come under careful study until later. However, immediately after the invasion of Africa, the report of rapid breakdown of our footwear and the extremely high replacement rate of all the soldier's personal equipment showed that there was an urgent need as well for the restudy of the serviceability of materials.

Salvage Studies

The first thing which was recognized by the Quartermaster Corps was the need for obtaining information on the actual nature and conditions of failure of end items. In August, 1942, a preliminary report (2) was presented on a study of salvaged garments, based upon which a plan was developed for classification of discarded items according to type and degree of failure.

Immediately following this report,

* Remarks made in acknowledging the Harold De Witt Smith Memorial Award at the meeting of ASTM Committee D-13 on Textile Materials, March 20, 1958, at Washington, D. C.

[1] U. S. Army Quartermaster Corps, research director, Textiles, Clothing, and Footwear, Research and Development Command, Natick, Mass.

[2] Amsler Wear Tester; Macy's Abrasion Tester; Eaton's Abrasion Machine; Matthew's Cloth Wear Testing Machine; Massachusetts Institute of Technology Abrasion Machine, the "Perspirator"; Shawmut Wear Testing Machine; U. S. Testing Co., Inc., Abrasion (Wear Test) Machine; Wyzenbeek Precision Wear Test Meter; National Bureau of Standards Carpet Wear Testing Machine; Schopper Abrasion Tester.

studies of salvaged items were initiated in three locations—Camp Lee, Va., Camp Edwards, Mass., Fort Sam Houston, Tex. The summary report (3) of these studies was completed in March, 1943. Several thousand items of salvaged clothing, footwear, and equipment were analyzed in these studies. Thus the test courses could be based upon the concept of reproducing accelerated wearing conditions with the same types and degree of failure which were found in the salvaged garments.

These early studies were supplemented by an extensive analysis conducted immediately at the end of the war by study teams which were sent both to the European and Pacific theaters, as well as to salvage collection points in the United States, to examine items selected on a statistical sampling basis from the salvage dumps at various locations in the combat area. Here again the aim was to determine the kind of wear and failure which occurred under actual service conditions in combat. Reports like "Salvage in the Western Pacific Area" (4) provided a great deal of information on clothing failures and, I might say, gave no basis for indicating that previous conclusions as to the design of our accelerated wear courses or our system of analysis required any essential modification.

Objective: Relate Service Life to Laboratory Data

From the studies on the combat course at Ft. Lee and the analysis of salvage data, it was apparent that a tool was available by which it might be possible to relate actual service life to some form of laboratory wear testing.

The Committee on Quartermaster Problems of the National Research Council, of which Lawrence W. Bass was the chairman, recommended that a study be made of the combat course, with a view toward determining, among other things, if a correlation could be made between the combat course results with laboratory abrasion methods. If this could be done, then, in future studies of military and other fabrics, laboratory methods could reliably and quickly predict what would happen to the textile materials under service conditions. This work was undertaken jointly by the Textile Division at Massachusetts Institute of Technology and the Fabric Research Laboratories. Walter J. Hamburger and Ernest R. Kaswell of Fabric Research Laboratories and Professors E. R. Schwarz and Kenneth R. Fox of M.I.T. provided technical leadership for this project. The results of this study appeared in the *Textile Research Journal* for September and October, 1946 (5).

One of the observations made by Dr. Hamburger and his co-workers during this early work was that maximum wear as well as maximum tension in the fabrics occurred in the warpwise direction. This was evident from the fact that warp yarns, which were exposed on the wearing surface and simultaneously strained, suffered the most damage on the combat course. The ideal fabric would accordingly be one in which the surface yarns would support no load in wear. Based upon this finding, action was taken to reverse our warp-flush sateen and to use the filling-flush side on the outside of the garment.

Research on Engineering Properties

Another phase of this same approach to the study of serviceability of fabrics was the research sponsored by our office at the Fabric Research Laboratories on the translation of fiber properties into yarns and fabrics. This work, which started in 1947 and continued through 1951, embraced the entire range of fabric engineering based upon the planned utilization of specific properties of fibers. Many detailed investigations were made of the fiber and yarn properties which contribute to the performance of textile fabrics; and basic relationships with regard to rupture failure, tear strength, and recovery properties were developed. For example, these studies revealed that for both staple and filament yarns, rupture properties and repeated stress properties could be related to and are dependent upon yarn geometry and stress-strain curves. The relationship of fabric tear strength in terms of yarn pull-out force, crimp and crimp balance, cover factor, fabric deformability, and load-elongation curve of the yarns themselves was developed both experimentally and analytically. The ability of a fabric to recover from a deformation such as creasing was shown to be related to increasing the opportunity for buckling by employing fabrics in which long floats are present, and by decreasing cover factor. The results of this work conducted by Dr. Walter Hamburger, Dr. Milton Platt, and their associate at the Fabric Research Laboratories have been reported in a series of articles in the *Textile Research Journal* (6). It was undoubtedly one of the most important fundamental contributions which have been made to the understanding of the engineering of textiles.

The status of our thinking on this problem was well summarized by Stanley Backer, who was a Captain in the Quartermaster Corps at the time. In an excellent summary entitled "Increasing the Wear Life of Army Textiles Through Research" (7), Dr. Backer pointed out how it had been determined from the studies conducted during the war that the most characteristic type of wear in clothing, other than edge abrasion, was that which characterized the wear on the knees and thighs of trousers. There were, accordingly, significant differences in the resistance of fabrics to such abrasion, depending upon the engineering of the fabric, the relationship of warp to filling yarns as to yarn size, twist, diameter, weave, and texture, and which yarns, warp or filling, received the brunt of the strain during wear.

I am sure you will realize how intrigued we were with the possibility of making a substantial increase in the service life of our textile fabrics through improved engineering of their design and construction. As Dr. Backer pointed out, if we could achieve only a 5 or 10 per cent increase in serviceability by some simple means, it would have an enormous value. When one considers that the Army purchased during World War II around 700 million yards of its 8.5-oz herringbone twill, nearly 200 million yards of its 5-oz combed poplin and oxford, and over 100 million yards of its 9-oz combed sateen, as well as enormous quantities of other textile fabrics, it will be evident what any such improvement would mean. To this must be added the cost of field maintenance and repair, the cost of transporting, storing, and issuing clothing in overseas theaters and to field units, all of which could be reduced by providing clothing of greater durability.

Extensive Wear Tests Provide Data for Correlation

Accordingly we undertook this study of the wear resistance of textiles as a major element in our Quartermaster postwar research and development program. For this purpose a carefully planned series of over 100 fabrics having controlled variations in design and construction was planned around the standard cotton herringbone twill fatigue fabric used by the Army during the war. The systematic changes in construction included variations of warp yarn count, filling yarn count, warp texture, filling texture, warp twist multiple, filling twist multiple, twist direction, staple length, and cotton variety. For this series the factors which were maintained constant were the finishing procedures and yarn preparation. A separate study was planned in which the construction of the fabrics was held constant and variations in finishing procedure applied to establish the relationship between chemically induced physical modifications of the fabric and service wear. The manufacture of this series of fabrics

from a single lot of carefully selected cotton was undertaken by the Institute of Textile Technology under a contract from our office and was supervised by Lewis Larrick, Director of the Department of Physics and Engineering at I.T.T.

When the fabrics were received, garments designed for combat course use were produced and submitted to test at Camp Lee, Va. It is of special interest to note that an increase in statistical precision of the test procedures was accomplished by designing a special "combat course" uniform having maximum plane surface area, achieved by eliminating flies, pockets, and other raised surfaces from critical portions of the garments. In addition, a group of test subjects were utilized who were modal with respect to wear scores. These subjects were selected from a group of medium-sized men whose wear scores were calculated after repeated traversals of the course in the specially designed garments. Those men who contributed the extreme values on either tail of the frequency distribution of wear scores were rejected.

Germans Made Significant Contributions

I should perhaps mention that in the course of the investigation of technical developments in Germany conducted by the Office of the Quartermaster General at the immediate conclusion of World War II, and by the Technical Industrial Intelligence Committee of the Joint Chiefs of Staff, we found a great deal of interest in Germany on this same subject. Part of it was brought about by the necessity of the "self-sufficiency program" of the Nazi government prior to the outbreak of the war and the necessity of their using almost entirely man-made cellulosic fibers both for civilian and military clothing. Because of the particular strength characteristics of rayon it was, accordingly, of really vital concern that anything possible be done to improve its serviceability in use.

Among the technical teams sent to Germany to investigate technical developments, one was given the specific objective of studying German research programs in this specific area. This team, which included Herbert Schiefer of the National Bureau of Standards, Richard R. Kropf of the Belding-Heminway Corp., and Lyman Fourt of the Harris Research Laboratories, reported on a large body of research, many studies of which had been published during the war. It was felt that this whole subject would be of sufficient interest to research people in the English-speaking world so that arrangements were made with *Melliand Textilberichte* to produce a volume of selected articles on this subject as a bound volume of reprints. This report which was released by the Office of Technical Services, U. S. Department of Commerce (**8**) contains some twelve articles on this subject prepared under the German "self-sufficiency" program, as well as some seven additional articles of related interest. A by-product of our German investigation was our contact with Reiner Stoll who at the time was the technical director for a rayon manufacturing concern at Kelheim, Bavaria. Julian F. Smith, who at the time was on the staff of I.T.T., reported on Dr. Stoll's work in the development of a new type of multi-purpose abrasion tester and his extensive studies on the interrelationship of rayon staple fiber characteristics, fabric manufacturing processes, and serviceability of the end product.

We got in touch with Dr. Stoll to see if he would be interested in coming to the U. S. to work on our program of textile fabric serviceability and we were pleased when he accepted. An opportunity was given to him to perfect the design of his abrasion tester, and, when it had reached a satisfactory stage, arrangements were made with the National Bureau of Standards to construct a machine embodying the various design features (**9**). Thus there came into being the Stoll-Quartermaster Universal Abrasion Tester which has since become one of the more or less standard test instruments available to fabric engineers in the textile industry.

At about the same time we were able to obtain from Germany Dr. George Susich who had been associated with I. G. Farbenindustrie. In his work for the Quartermaster Corps, Dr. Susich pioneered in the evaluation of the recovery properties of textile fibers. As part of his basic program on the evaluation of mechanical properties of fibers, he developed a technique (**10**) for measuring the abrasion behavior of filament and staple yarn using the flex element of the Stoll tester. He evaluated 14 different textile yarns in terms of abrasion damage which had the advantage of providing information more closely related to the inherent abrasion behavior of the fiber material itself, free of the complicating factors of fabric weave, texture, and finish.

One further aspect of this program which is of special interest is the study undertaken by Dr. Backer, Dr. Stoll, and S. Tanenhaus on the correlation of the combat course with the Stoll Abrader and with actual service wear of clothing by troops.

The evaluation of the different fabric constructions in the wear-resistant series of fabrics on the combat course had already confirmed many of the preliminary findings with respect to the effect of fabric structure upon serviceability and use. However, it was obviously desirable to see if the kind of wear which had been experienced on the combat course could be reproduced in the normal wear of clothing by soldiers.

Normal Wear Studies

Accordingly, a correlation study was planned in which 200 recruits undergoing basic training at Ft. Jackson, S. C. were provided with standard herringbone twill clothing made into the special combat course design. It was felt that the most severe and representative type of wear that could be had in peace time would be with such a newly activated recruit training company while they were going through their basic training. The garments were issued according to a fixed plan, being worn one week, laundered, and then scored by the same scoring system used for the combat course.

It was found that the wear pattern obtained in these garments was very similar and the rate of wear almost exactly parallel to that encountered on the combat course. It was found for example that the 13 weeks of wear were equivalent in total wear score to approximately 20 traversals of the combat course. Furthermore, during this time the degree of wear was sufficiently great to approximate a substantial part of the total service life.

Having established a quite gratifying relationship between the combat course and normal service wear, the next attempt of this team was to see if any of the laboratory instruments, and particularly the new Stoll-Quartermaster Universal Abrasion Tester, could provide a similar type and degree of abrasion in the laboratory.

Stoll and Field-Test Data Agree

It was soon found that the flex test which was one of several types of wear capable of reproduction on the Stoll machine gave a remarkably high degree of correlation with the combat course. Actually on twelve fabric systems a correlation coefficient of 0.94 was obtained.

On the basis of testing on these three levels—service use, the accelerated combat course test, and the laboratory test—a correlation in the wear pattern had been obtained which in a sense represented a culmination of our test development efforts.

The acceptance of the Stoll tester since the publication in 1949 of Dr. Stoll's paper in the *Textile Research Journal* (**11**) is well known. I believe it

would not be incorrect to say that it is probably one of the most widely used laboratory research instruments in the textile field today.

Dr. Backer's recent studies in the geometry of textile materials will, I am sure, continue to merit the most careful study by all workers in this field. Louis Weiner, who succeeded him in charge of this program and who is now Assistant Chief for Research of the TC&F Division of our Center, brought this program to completion and opened new fields of study in textile serviceability which are directly applicable to military requirements.

Carded Sateen Replaces Herringbone Twill

From this development work one of the concrete contributions was the replacement of the herringbone twill by our carded sateen fabric. This fabric was found by both laboratory and combat course testing to show a wear index of approximately 1.8 times that of the original herringbone twill. This wear index was a computation based upon the evaluation of the combat course results and shows the ratio of durability of the new fabric to the standard herringbone twill.

Other applications of these principles are to be found in the approaches we have taken in many of our fabrics in the use of sateen waves with specifically planned yarn and fabric geometry. Also it has been possible to apply the same principles in plain and twill weave constructions. In many of our fabrics, of course, wear resistance is only one of many functional properties which we require for the material to serve its intended use. Ultimate constructions represent a compromise of many of these features, but in all of them we have been able to take advantage of this knowledge of the principles of wear resistance in construction to seek to maximize this particular property along with other properties such as water resistance, wind resistance, tear resistance, and thermal resistance, etc.

New Problems

I would be misleading, however, to imply that we had solved all of our problems in this area. For example, within the last year we have tried out a particular fabric containing nylon staple and cotton, which, based upon the Stoll abrasion test results and tests of combination nylon-cotton fabrics in the wear resistance series, should have shown very substantially increased wear resistance over the all-cotton fabric. On the combat course, however, the two fabrics were indistinguishable. Just why this particular fabric, which was lighter in weight than those in our previous test, should have behaved this way we do not know. However these data do show that we should not extrapolate too far and that recourse to actual service conditions of test must be made whenever any basic shift from one fabric to another is made in the ground rules one is following. We feel very sure from our previous work, however, that a properly engineered nylon-cotton fabric will outwear an all-cotton fabric, other things remaining equal.

In summary, I feel that people who have the development of laboratory test methods so much at heart and who appreciate so well the importance of making even slight improvements in methods of testing will appreciate some of the contributions which the members of our staff have made in this field. To all of them I would like to pay my personal tribute and express the gratitude of the Corps for what they have contributed in this field of military progress and the public welfare.

Fabrics for Space Age

There are some of you, no doubt, who have been asking yourselves, "What is the relevance of all of this in a space age? Do we in textiles belong to a forgotten segment of the economy in these days when in order to get anyone to listen to you—at least in some quarters—you have to use the word space in your opening sentence?"

If we in the textile industry must stake out a claim in space to which we can hold fast for a legitimate claim for recognition among the electronics, missile, fuel, ceramics, and metals people who presently seem to think that space is their special reserve, then may I point out that the only thing that has come back from space safely—the nose cone of the Jupiter missile—was borne back to earth on a parachute made of textiles.

Also, considering the capability of textiles to provide the greatest drag-to-mass ratio of any known materials, it is quite probable that textiles will continue to have such a role for a long time to come. In other words our space travelers both animate and inanimate are probably going to have to look to textiles as their descending elevator through our atmosphere.

Of course we can add a word or two about the clothing to be worn by space men. No iron or plastic pants have yet been found to be as comfortable as those made of textiles, and comfort will still be important to humans when they leave our earth for other destinations—that is, I mean in space ships.

And it is quite possible that on space platforms space shelters of textiles may be found to be very useful—they will be lighter than any other kind even as they are here on earth and, since there is no weather in space, a completely flexible shelter may be quite adequate.

However, let us not get so carried away by such visions that we fail to remember what kind of a world we are still living in. For victory in war, armies are still needed, and that applies whether one is talking about limited war or total war. And when we talk about logistic support of an Army, we mean in a very big way—textiles.

So textiles are still relevant to the military picture and still have within them, where they are used in military clothing and equipment, the same potentiality which has always been held out to our industry of giving to the combat soldier an edge over his opponent which can mean the difference between his failure or success.

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Nuclear Radiation Effects on Materials*

Review of basic principles and summary of current knowledge.

By GERALD REINSMITH

Definitions

rep (*Roentgen Equivalent Physical*).—The amount of radiation energy which produces an absorption of 93 ergs in 1 g of soft tissue or water.
Megarep.—Million roentgen equivalent physical.
rem (*Roentgen Equivalent Man*).—Amount of ionizing radiation of any type which produces the same damage to man as 1 r of about 200-kv X-ray radiation.
rad.—Absorbed dose of 100 ergs per g.
Slow Neutrons.—Neutrons with energies below 1 ev.
Intermediate Neutrons.—Neutrons with energies from 1 ev to 10^4 ev.
Fast Neutrons.—Neutrons with energies of 10^4 or more. (The range of neutron energies is generally considered from 10^{-3} to 10^4 ev and the range of sizes varies from 10^{-4} to 10^{-12} cm.)
Thermal Neutrons.—Slow neutrons which are in thermal (or molecular) equilibrium with their surroundings.
Epithermal Neutrons—Neutrons with energies just above the thermal region (low intermediate range).
nvt (Integrated Flux).—Number of neutrons incident per unit area for the total time that the specimen is exposed.

n = neutrons per unit volume in incident beam,
v = neutron velocity, and
t = exposure time.

Recoil Atoms.—Atoms set into motion by a collision with particles of matter (mostly neutrons).
Barns.—Numerical designation of the absorption cross-section (1 barn = 20^{-24} sq cm per nucleus).
Compton Collision.—Elastic scattering of photons by electrons.
Threshold Energy.—Source required to displace atoms (in general, 25 ev).
High Flux Reactors.—Having a power density above 1.8.

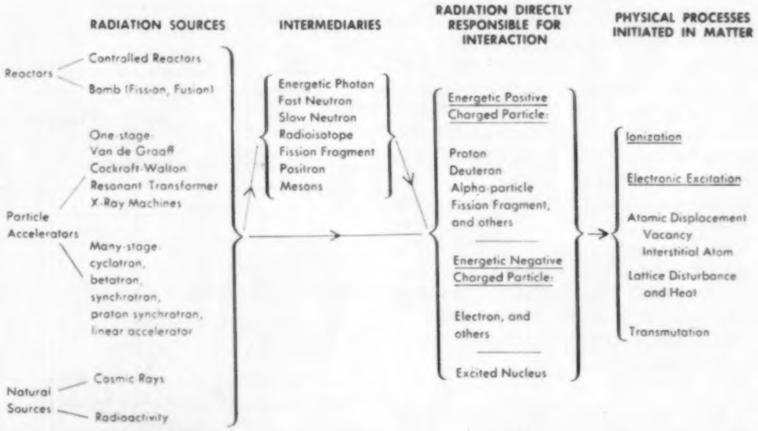

Fig. 1.—Varieties of atomic radiation and their different interactions with matter (from Reference (3)).

Due to the increasing importance of nuclear weapons, the construction and use of nuclear reactors for research and power, as well as the use of radiation as a tool for increasing our understanding of the physics of solids, data concerning radiation effects on materials or, as has been popularly known in the past as radiation damage, are becoming of greater importance. The current applicable programs are numerous and the expenditure of time and funds are tremendous, as will be covered later in the presentation.

When we speak of radiation effects, we must be careful to define the type and source of radiation used. These can include the nuclear pile or reactor as our most important source where neutron and beta particles and gamma rays are released directly; high-energy electrons emanating from radioactive beta decay or from machine accelerators; and electromagnetic radiation of the X-ray or gamma-ray variety.

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* The opinions or assertions herein are not to be construed as official nor reflecting the views of the Department of the Army.

[1] The boldface numbers in parentheses refer to the list of references appended to this paper.

[2] Recent compilation of all reactor facilities in this country is contained in AEC Report TID-7009.

Radiation Sources.

From the first column or radiation source as shown in Fig. 1, it may be noted that there are several important irradiation facilities which govern the strength of radiation field and depth of penetration (**3**).[1]

Reactors.—Neutrons and gamma rays are available from radiation in reactors.[2] The thermal neutron flux varies from 10^{11} to 4×10^{14} neutrons per sq cm per sec and is accompanied by fast neutrons

G. REINSMITH was employed in the Office Chief of Ordnance from 1943 to 1953 where he was actively engaged in research on nonmetallic materials and their applications in Ordnance material. Following employment with Narmco, Inc., in California, Mr. Reinsmith returned to government duty as Chief of the Research Branch, R & D Division, Headquarters Ordnance Weapons Command, Rock Island, Ill. His duties include monitoring the general field of nuclear radiation, staff supervision of experiments in solid state physics, radiography, fluoroscopy, and the review of possible modifications in weapon characteristics which may be caused by changes in material properties due to nuclear radiation exposure.

and gamma rays. The radiation field is roughly in the order of 10^5 to 10^9 r per hr.

Testing on a reactor is difficult and expensive; the cost of a test series can easily reach $100,000. The working space is limited; shielding, handling, and instrumentation problems are complicated, and there is the problem of removing the heat produced by the gamma radiation (**21**). Because of the heterogeneous character of the radiation from reactor exposure along with poor control of the flux to which the specimens are exposed, interpretation of results is extremely difficult. In addition to electronic ionization and excitations, two other effects may be noted in reactor irradiated samples. If the sample contains high neutron capture atoms, it will become radioactive. For high polymers in general, the radioactivities are either short-lived or relatively weak. In addition, the fast neutrons will cause displacement of atoms more severely than electron irradiation.

Accelerators.—Although there are various types of machines such as cyclotrons, synchrotrons, betatrons, and linear accelerators for the acceleration of charged particles one of the most practical sources for general application today is the modern Van de Graaff generator. A typical model provides a 250-μamp 2-Mev electron beam in an area approximately 1 by 15 cm and a depth of penetration of about 1 cm in high polymers of unit density. It is possible to deliver a radiation dose of the order of 4×10^6 roentgen equivalent physical (rep) in 1 sec or about 10^{10} rep in 1 hr. Machines are manufactured in standard models to 5.5 Mev. The main limitation of the electron beam is its restricted depth of penetration. Cost and efficiency are shown on Figs. 2 and 3 (**32**).

Radioisotopes.—Gamma rays are available from radioisotopes, spent fuel elements, and fission by-products. Cobalt-60 is the most commonly used radioisotope today and is usually available in 1 to 10 kilocuries strength with a half life of 5.3 yr. Radioisotope uses can be divided into two groups. In one, radiation is used to accomplish some useful process. Radiography is a typical use with gas ionization, pasturization of foods and drugs and radiation effects on chemical processes being other applications. The other group of radioisotope applications involve the tagging of systems which require study. Mechanical parts are tagged and then located by radiation measurements when visual observation is not possible. Other systems are tagged to permit the tracing of minute quantities of material. The tracking of a particular chemical element through complex chemical processes also is possible (Fig. 4).

It has been estimated that by 1960, isotopes may save U. S. industry and agriculture $5 billion a year at a cost to the Government of $20 million. Thus, in about 3 yr, Willard F. Libby, Atomic Energy Commissioner, says, "...isotopes probably will be paying the whole way for the atom," and the Western World will be getting its atomic armaments and atomic power development "all free" (**42**).

Type	*Manufacturer*	*Beam Energy (m.e.v.)*	*Beam Current (ma.)*	*Beam Power (kw.)*	*Approximate Price*
Resonant Transformer	General Electric	1	6	5	$ 69,000
Resonant Transformer	General Electric	2	6	10	120,000
Van de Graaff	High Voltage Engineering	1	0.25	0.25	39,000
Van de Graaff	High Voltage Engineering	2	0.25	0.50	70,000
Van de Graaff	High Voltage Engineering	3	1	3	126,000
Linear Accelerator	Varian Associates (Army Ionizing Radiation Center Contract)	24		18	625,000
Linear Accelerator	Applied Radiation	10	0.7	4	145,000

Fig. 2.—What electron accelerators cost today.

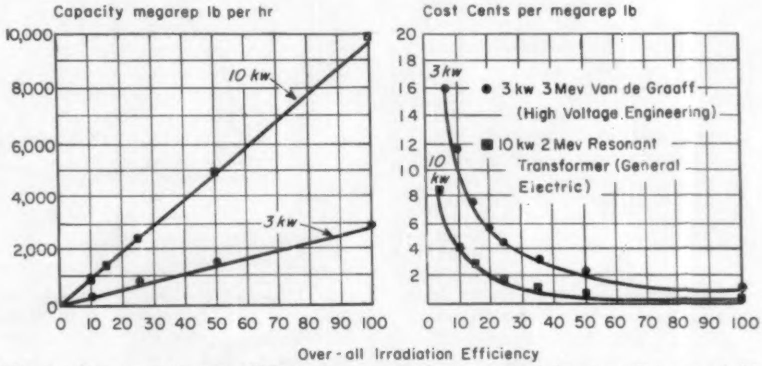

Fig. 3.—Larger and more efficient electron accelerators, (a) bring capacity up, and (b) bring cost down (from Reference (32)).

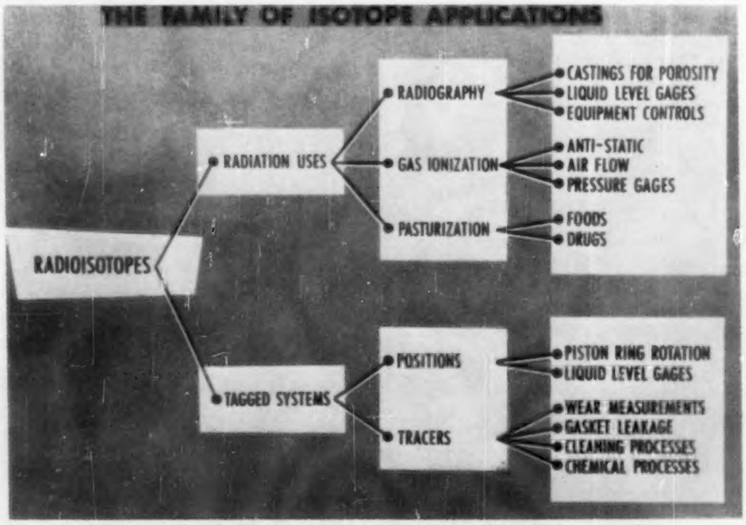

Fig. 4.—The family of isotopes applications (from Reference (7))

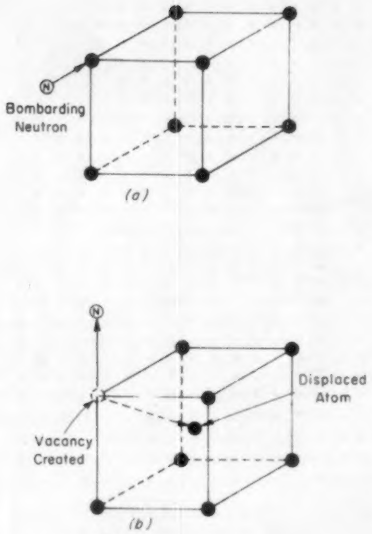

Fig. 5.—(a) Perfect, simple lattice with neutron striking an atom. (b) Lattice defect caused by neutron knocking atom out of normal position (from Reference (25)).

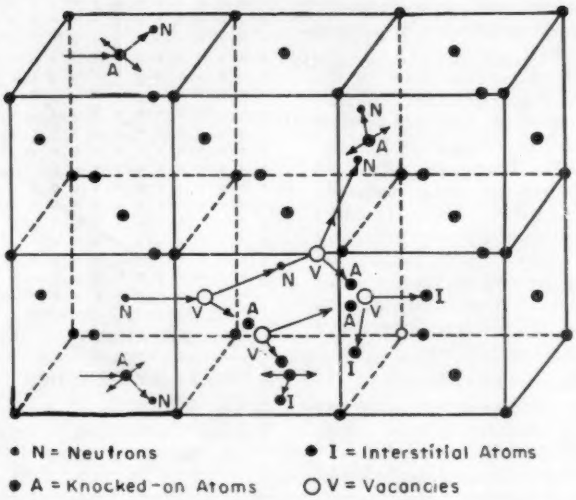

Fig. 6.—How irradiation damages materials (simplified theory) (from Reference (1))

Spent Reactor Fuel.—Spent fuel elements from reactors are usually dumped into a deep water canal to "cool." These slugs may be arranged to give a uniform gamma-ray field above or inside the submerged fuel element assembly. The radiation field varies with strength and age of the fuel elements. It generally ranges from 5×10^3 to 5×10^7 r per hr. These will probably be the cheapest source of radiation.

Fission by-products may include waste solutions, separated isotopes, or gaseous fission products liberated from a homogeneous reactor. Although much discussion and thought has been concerned with the use of fission by-products for irradiation, very few practical sources have made their appearance as of today.

X-Rays.—X-rays from the ordinary X-ray machines provide radiation fields comparable to or larger than that from kilocurie radioactive cobalt-60 sources. For example, an industrial X-ray machine running at 200 kv and 10 ma is capable of delivering 4×10^5 r per hr over a 2-in. diameter near the window of the tube. Using beryllium windows, some X-ray tubes are capable of delivering 10^{14} r per hr in ordinary plastic of 1 mm thickness. Since X-rays are produced from electrons rather inefficiently, it would seem uneconomical to use X-rays instead of electrons. However, high-voltage X-rays have the special advantage that their depth of penetration in a given material is much higher. This is also true for gamma rays.

Protons, deuterons, alpha particles, and fission fragments as particles from modern cyclotrons or other nuclear machines are capable of producing much higher radiation doses in thin sections of materials than any of the other sources mentioned above. In a high-intensity deuteron beam it becomes difficult to control the temperature. For fission fragments, ionization density per incident particle is highest of all. Under such conditions, phenomena not common to other radiations may be expected.

Mechanisms of Radiation Effects

Before discussing the radiation effects on materials which can be broken down into the general fields of metals and polymeric materials, it may be well to review briefly the concepts by which the properties of materials are changed when they have been irradiated.

Displacement.—Three basic concepts have been proposed to explain the many metal changes ascribed to neutron irradiation (**25**). In the displacement concept, metal change by displacement is a mechanical concept. A neutron, having no charge, does not interfere with the atom electrons in a metal. With high kinetic energy, it proceeds until it collides with an atom nucleus, displacing an energetic atom to some other position within the lattice. The result is an interstitial atom, a vacancy at the original atom site, and a change in direction of the bombarding neutron. This sequence of events is shown in Fig. 5. Displaced atoms can also elastically collide with other atoms if sufficient kinetic energy was imparted by the original colliding neutrons. These created lattice defects are manifested by changes in physical and mechanical properties.

Formation of Thermal Spikes.—Under the thermal spike concept, bombarding neutron energy is lost to atoms adjacent to the particle path, creating intense local heating. This energy conversion, confined to a small volume, results in sharp temperature gradients or "thermal spikes." Resulting temperatures, calculated in the order of 1300 to 2200 Kelvin for 10^{-10} sec are sufficiently high to melt and possibly to vaporize the metal locally. Rapid conduction of heat to adjacent areas results in distorted regions at the spike sites upon solidification, affecting properties of the metal on a macroscopic scale.

Formation of Impurity Atoms.—By the impurity atom concept, property change under neutron bombardment also can be interpreted metallurgically in terms of solution hardening. Here, certain alloys are formed by solution of a secondary component metal in the major component metal at elevated temperatures. Precipitation from supersaturated solution changes many alloy properties. By the impurity atom concept, the bombarding neutron is captured by the struck atom, forming a new atomic element. This "impurity" atom acts as the second component metal in the solution-hardening analogy. For example, a neutron captured by a rhodium-103 nucleus forms radioactive rhodium-104. This decays by beta particle emission to palladium, which becomes the impurity atom. Property changes by

formation of impurity atoms are thought to be less significant than those caused by displacement.

Figures 6 and 7 show some of the expanded theories concerning attenuations of radiation by material including the concepts of knock-on and interstitial atoms (**1, 17**). Irradiation effects on metals are large in some instances, negligible in others. Many variables coexist such as the type, intensity, and dosage of radiation; type, purity, and initial state as well as prior thermal and mechanical history of the material and character, temperature, and pressure of the surrounding medium.

Effect on Properties of Metals

In general, changes in bulk properties of metals by irradiation are not significantly different from those produced by conventional metallurgical methods and are dependent on atomic number, melting point, crystallographic structure as well as the alloying elements or impurities including chromium, manganese, cobalt, copper, zinc, tantalum, and tungsten which are subject to induced radiation (**13**).

In heavily cold-worked metals, radiation may produce effects similar to an annealing heat treatment, indicating that it is not completely analogous to cold work. Effects of radiation resemble solute hardening more than they resemble cold work, but the magnitude of the property changes is much greater than those produced by solid solution alloying. For solid-state processes in which diffusion is the primary mechanism, radiation is equivalent to an increase in temperature. Thus, precipitation hardening reactions and order-disorder transformation are accelerated by irradiation (**21**).

Certain radiation effects can be removed; others cannot. Property changes caused by bombardment-induced formation of new elements are irreversible. Changes in hardness and resistivity, resulting from atomic displacements, however, can be removed by a process similar to the annealing of work-hardened metals. Heating the irradiated metal to the temperature at which the vacancy and interstitial atom can recombine restores original properties.

Physical Properties.—Usually changes upon irradiation in electrical resistivity of metals and alloys are not significantly great (Table I). However, electrical resistivity increases of 3.1 to 23.8 per cent following exposures of 7×10^{19} fast neutrons per sq cm at 70 to 90 C have been recently reported (**38**). While changes do occur in mechanical properties, the "damage" is not sufficient to impair the structural and engineering utility of nonfissionable metals (**13**). Some engineers do not accept this generalization, but apparently the present reactor designs can tolerate such property changes as do occur in those materials with which they are interested (Fig. 8). Yield strength and tensile strength generally increase upon irradiation, with the gap between yield strength and tensile strength narrowing, particularly if the temperature of bombardment is low compared to the melting point (**17**) (Tables II and III). At an exposure of 10^{20} neutrons per cm sq, the yield strength of stainless steel is close to ultimate strength and no marked change in Young's modulus is observed up to 5×10^{18} neutrons per sq cm (**13**). Another report shows increases in ultimate tensile strength

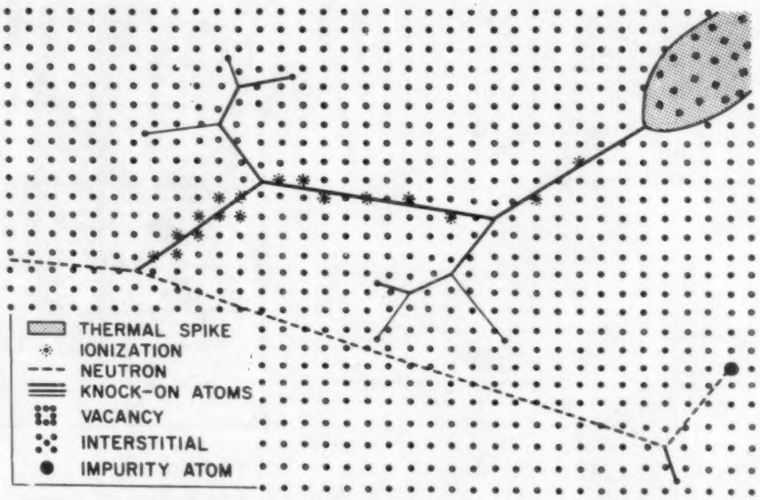

Fig. 7.—Schematic representation of radiation damage in a solid, showing ionization, thermal spikes, displacement atoms and cascading of knock-on atoms (from Reference 17)).

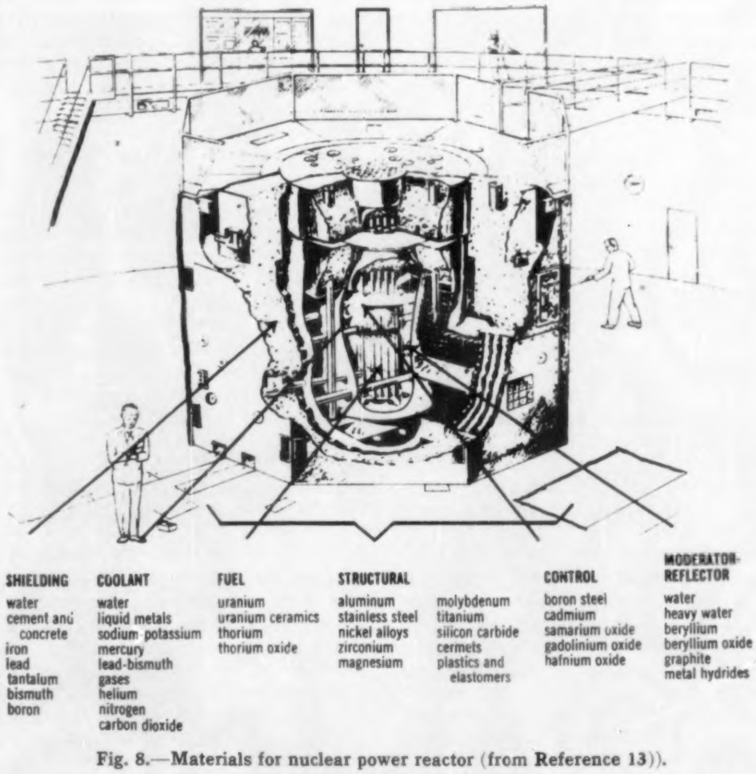

Fig. 8.—Materials for nuclear power reactor (from Reference 13)).

after radiation exposure of 10^{20} nvt of 10 per cent for carbon steel, 20 per cent for stainless steel, 40 per cent for nickel, and 5 per cent for zirconium (**17**). Nickel has been reported to show an ultimate tensile strength increase of better than 50 per cent when exposed at 2×10^{20} neutrons per sq cm at 180 C. Cold-worked 1100 aluminum exhibits an increase of 22 per cent in yield strength after exposure to 2×10^{20} neutrons per sq cm at 30 C and 26 per cent increase in ultimate strength. Other investigators have reported increases in yield strength of metals of as much as 63 to 453 per cent (**38**).

Ductility and related properties such as elongation decrease and the transition temperature can be substantially increased, even as much as 250 F in pressure vessel steels. In face-centered cubic metals, such as austenitic stainless steels, neutron radiation causes the temperature of a definite yield point in a stress-strain curve, and this is more pronounced at higher strain rates (**21**). Except for titanium, metals are reported to acquire discontinuous yield point (to give way abruptly when a certain point in strain is reached) under exposures up to 7×10^{19} fast neutrons per sq cm at 70 to 90 C (**38**).

Increased hardness of the order of 10 per cent for type 347 stainless steel when exposed at 1 to 3×10^{20} nvt at 80 C has been reported (**13**) with other investigators claiming general increases of 100 per cent for stainless steels after radiation of 10^{20} nvt (**17**). Increase in carbon steels seems to be about 40 per cent after exposure of 10^{20} nvt (**17**). Nickel shows hardness increases of more than 120 per cent under exposures of 2×10^{20} neutrons per sq cm at 180 C. Cold-worked 1100 aluminum exhibits increases of approximately 15 per cent in hardness after exposure of 2×10^{20} neutrons per sq cm at 30 C. However, at 200 to 250 C, above which the aluminum recrystallizes, radiation does not cause hardening (**13**). Zirconium under radiation of 10^{20} nvt shows hardness increase of 100 per cent (**17**) (Table IV).

The impact strength of stainless steel is considerably lowered and the brittle ductile transition temperature is raised from 50 to 100 C after exposure at 10^{19} neutrons per sq cm (**13**). The temperature at which molybdenum makes transition from ductile to brittleness is increased 100 C following exposure up to 7×10^{19} fast neutrons per sq cm at 70 to 90 C (**38**).

Most metals show only slight changes in density following radiation (Table V).

In general, metals show very little change in creep at room temperature after radiation in the order of 10^{21} nvt (**17**). Nickel shows very little change in creep rate at 700 C with a beam loaded with maximum fiber stress of 141 kg per sq cm upon exposure to a dosage of 3×10^{11} neutrons per sq cm (**13**).

Zirconium shows a marked increase in creep after exposure of 3×10^{12} neutrons per sq cm per sec.

Zirconium also shows an increase in energy to fracture of 200 per cent on impact tests conducted at −78 C on samples exposed to 3×10^{19} neutrons

TABLE I.—EFFECT OF IRRADIATION ON ELECTRICAL RESISTIVITY (FROM REFERENCE (1)).

Material	Electrical Resistivity, Micro-Ohm-Cm	
	Before Irradiation	After Irradiation
STAINLESS STEELS		
304	80.2 at 28.0C	80.4 at 27.8C
309	79.9 at 27.5C	82.01 at 27.0C
316	77.0 at 28.4C	78.01 at 28.4C
347	75.5 at 26.2C	75.94 at 27.3C
NICKEL-BASE ALLOYS		
Nickel-A	9.8 at 27.0C	9.63 at 27.2C
Hastelloy-C	126.5 at 26.2C	133.80 at 27.8C

TABLE II.—EFFECT OF IRRADIATION ON TENSILE STRENGTH OF SOME METALS (FROM REFERENCE (1)).

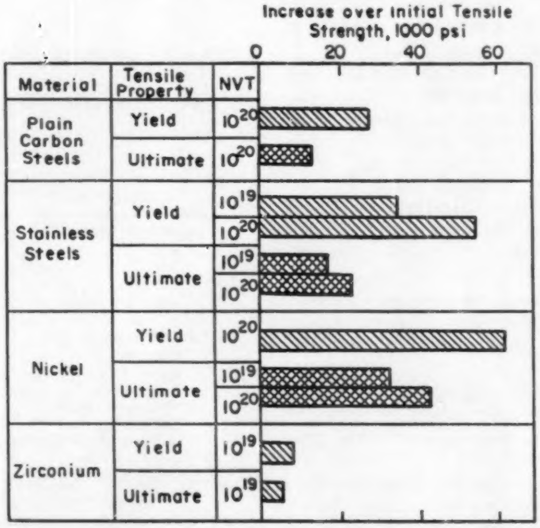

TABLE III.—PRE- AND POSTIRRADIATION VALUES OF HARDNESS, AND YIELD AND TENSILE STRENGTH OF VARIOUS ALLOYS.

	Rockwell Hardness Number		Yield Strength, psi		Tensile Strength, psi		Ratio of Yield Strength to Tensile Strength	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
2SH14 aluminum	F8	F40	18×10^3	23×10^3	20×10^3	27×10^3	0.9	0.85
2SO aluminum	...	...	7	17	17.3	26	0.51	0.65
High purity iron	...	...	18	31	36	37	0.5	0.84
Normalized carbon steel	...	...	50	93	75	97	0.67	0.96
Hardened and tempered alloy steel	...	...	153	196	164	198	0.93	0.99
Austenitic stainless steel	B81	B99	37	97	98	115	0.38	0.84

per sq cm. Subsequent irradiation to 6×10^{19} neutrons per sq cm reduced it to the preirradiation value (**13**). The impact strength of stainless steel is considerably lowered when radiated at 10^{19} neutrons per sq cm (**13**).

Bleiberg states it is a reasonable assumption that the change in impact and tensile properties is directly proportional to the integrated flux in the range of 1×10^{18} to 1×10^{19} nvt for type A-302 steel. However, caution must be exercised in extending this assumption as an exposure of 1×10^{20} nvt caused a greater change in both impact and tensile strength than an exposure of 1×10^{19} nvt (**34**).

Effect on Ceramics

Ceramics are less resistant to the effects of severe irradiation than metals. There are indications, moreover, that in some ceramics these effects will "self-anneal." Radiation effects in ceramics are generally smaller at high temperatures and physical changes produced by irradiation will generally be removed at elevated temperatures (**13**).

The principal radiation damage effect in graphite is distortion of the lattice and trend toward amorphous form. Neutron-irradiated graphite becomes harder, stronger, more brittle, more difficult to machine, and exhibits decreased thermal conductivity. Conductivity may be reduced by a factor of 50 or more. Electrical resistivity rises quickly at around 2×10^{20} neutrons per sq cm, decreases slightly, then begins a slow increase again. Damage in irradiated graphite, however, can essentially be removed by suitable annealing treatments or practically prevented by maintaining temperature above 500 C during irradiation procedures (**13**).

Beryllium has nuclear properties that make it particularly attractive. It has excellent stability under irradiation. Under an exposure of 5×10^{18} neutrons per sq cm at 30 C, no significant changes occur in length, density, hardness, modulus, electrical resistivity, or thermal conductivity. Under irradiation of 10^{19} neutrons per sq cm, beryllium oxide shows serious decreases in thermal conductivity and compressive strength at room temperatures and dimensional changes of the order of 1 per cent are produced (**13**).

Effect on Polymers

When polymers are subjected to high-energy radiation, they are all ultimately destroyed; that is, their useful properties are destroyed. This may vary by a factor of more than 1000 (**8**). However, the use of gamma and beta rays from radioactive sources and of high energy elec-

TABLE IV.—EFFECT OF IRRADIATION ON HARDNESS OF SOME METALS (FROM REFERENCE (1)).

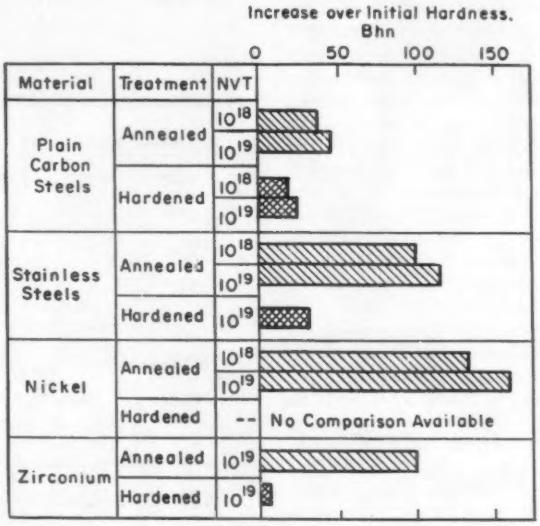

TABLE V.—EFFECT OF IRRADIATION ON DENSITY OF STRUCTURAL MATERIALS (FROM REFERENCE (1)).

Material Type	Average Density, gm/cc		Average Change, %
	Before Irradiation	Difference, After Irradiation	
STAINLESS STEELS			
316	7.995	−0.005±0.002	−0.06
347	7.938	−0.007±0.002	−0.09
347+Ta	7.942	−0.003±0.001	−0.04
410	7.675	−0.004±0.001	−0.05
NICKEL-BASE ALLOYS			
Nickel-A	8.894	−0.006±0.002	−0.07
Monel	8.836	−0.004±0.003	−0.05
COBALT-BASE ALLOYS			
Stellite 3	8.550	+0.005±0.002	+0.06
Stellite 6	8.330	+0.009±0.001	+0.11
CARBON STEEL			
SA-212	7.850	0±0.003	0

Radiation Exposure: nvt of 2×10^{19} slow and 3.5×10^{18} fast at 70–140 F.

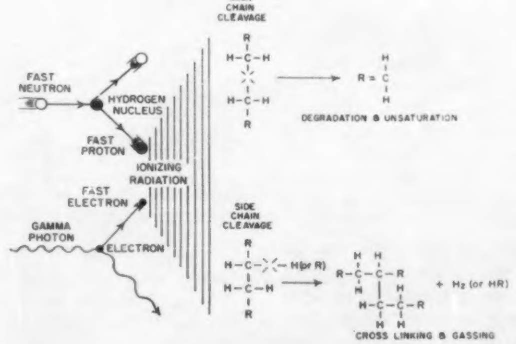

Fig. 9.—Reaction of nuclear radiation with a hydrocarbon polymer (from Reference (8)).

trons from accelerators have resulted in rapid development in the radiation chemistry of plastics and elastomers. Concepts as to how organic polymers are changed by radiation are significantly different from that for metals because of the fundamental difference between the metallic and covalent bond. When metals are irradiated, electrons are displaced but not necessarily permanently. If electrical balance is restored, the system recovers its initial state. In organic polymers, however, chemical bonds are broken which yields fragments of different sizes and gaseous decomposition products. In metals, then, irradiation effects are reversible, whereas in organic polymers they are irreversible (Fig. 9).

Propagation.—Gamma-rays interact with electrons at an energy level many times that holding the electron in the atom. Consequently, ionization and free radicals occur. Although the energy of the ejected electron is less than that of the bombarding gamma ray, it will still be many times the electron binding energies and further ionizations take place. The net result is the formation of many ions and free radicals from the action of a single gamma photon.

Types of Bond Cleavage.—Organic polymers are composed of interlinked molecular chains. Ion and free radical formation upon irradiation may occur in either the main or side chain of the polymer. Although bond cleavage occurs in either position, the net effect on the bulk properties of the polymer is different. Bond cleavage in the side chain produces further cross-linking and hence polymer strengthening; however, main chain cleavage generally leads to polymer degradation, with a marked change in tensile strength and other properties. Amount of change depends somewhat upon the molecular weight of the polymer employed.

Bond cleavage can, therefore, yield either degradation or crosslinking. This does not mean that one or the other will occur alone. Actually, all polymers degrade and cross-link simultaneously when irradiated, but one effect predominates over the other, depending upon the structure of the polymer (**26**).

Polymers that show cross-linking include polyacrylic esters, polystyrene, polyesters, nylon, polyethylene, natural rubber, styrene-butadiene, butadiene-acrylonitrile, neoprene, and polydimethylsiloxames. Those that show degradation include poly(methyl methacrylate), poly(vinyl chloride), poly-(vinylidine chloride), Teflon, Kel-F, cellulose, and polyisobutylene which are noncrystalline (**4**). However, Teflon, nylon, and polyethylene exhibit crystallinity (orderly arrangement of polymeric chains) which is lost when irradiated.

Materials with the benzene ring in the polymer chain show much poorer radiation stability than materials like styrene and aniline formaldehyde, where the benzene ring is attached to the side of the chain (**8**) with some correlation possible between chemical structure and stability to radiation (Fig. 10).

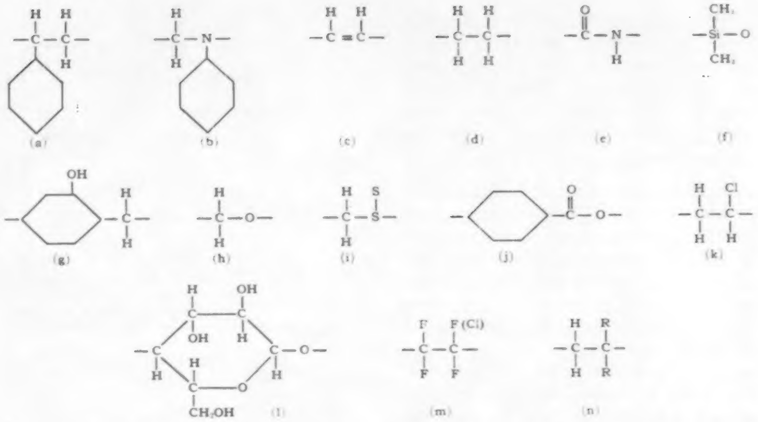

Fig. 10.—Series of chemical groupings ranked in order of radiation stability. The high stability of groups (*a*) and (*b*) is attributed to the presence of the phenyl ring. Low stability of plastics in group (*n*), for example methyl methacrylate, is believed due to quaternary carbon (from Reference (4)).

TABLE VI—RADIATION RESISTANCES OF PLASTICS (FROM REFERENCE (4)).

Plastic	*Exposure*	*Change in properties*
	10^{17} nvt	
1. Mineral-filled furan and mineral-filled phenolics: Duralon, Haveg 41, asbestos-fiber Bakelite, asbestos-fabric Bakelite, and Karbate	10	Little change except for darkening in color
2. Styrene polymers: Amphenol and Styron 411 C	10	Little change except for darkening in color
3. Modified styrene polymer: Styron 475	10	Impact strength and elongation decrease until the same as unmodified styrene polymers
4. Aniline-formaldehyde (Cibanite) and polyvinyl carbazole (Polectron)	10	Tensile strength decreases a little
5. Polyethylene and nylon	10	Impact strength decreases but tensile strength increases. These plastics become so brittle that the corners of the specimens chip off
6. Mineral-filled polyester: Plaskon alkyd	10	Tensile strength and impact strength are decreased about 50%
7. Unfilled polyesters: Selectron 5038 and CR-39	5	Develop small cracks. Tensile strength and impact strength decrease
8. Phenolics with cellulosic fillers: paper-base Bakelite, linen-fabric Bakelite, and Micarta	3	Become brittle, swell, and decrease in tensile and impact strength decrease
9. Melamine and urea: Melmac, Beetle, Plaskon urea, and Plaskon melamine	2	Tensile strength and impact strength are decreased about 50%
10. Unfilled phenolic: Catalin	1	Tensile strength and impact strength are decreased about 50%
11. Vinylidene chloride (Saran B-115) and vinyl chloride acetate (Vinylite)	0.5	Soften, blacken, evolve HCl, and decrease in tensile strength
12. Casein (Ameroid), methyl methacrylate (Lucite), Teflon, Fluorothene, and the cellulosics: cellulose nitrate (Pyralin), cellulose acetate (Plastacele), cellulose acetate butyrate (Tenite II), cellulose propionate (Forticel) and ethyl cellulose (Ethocel R-2)	0.1	Tensile strength and impact strength are decreased about 50%

Physical Properties.—Tensile strength, hardness, elongation, and other properties have been determined to be a function of total dosage. Within a factor of two, no difference has been noted in the effect of pile *versus* gamma irradiation for equal energy absorption (**4**).

We have learned much about what to expect of other plastics by what we know about polyethylene (**4**) in the group 5 (Table VI) which cross-links when subjected to high energy radiation and some unsaturation is produced. It becomes dark in color after prolonged irradiation, gives off large quantities of gas, and becomes hard and brittle. The breaking load increases slightly for the shorter irradiation periods, and the elastic modulus increases. Also, the melting point increases, and it becomes clearer or less hazy (**8**).

In group 12, Teflon shows no outward appearance of being changed, but the very rapid chain cleavage and deterioration is quickly evident when a nail is punched through it. The radiation dose is very low even for organic materials. The saturated ring structure of the cellulosics is very vulnerable and large quantities of gas are evolved. Failure is by chain cleavage (**8**).

Irradiated poly(methyl methacrylate) also suffers very rapid deterioration due to chain cleavage and evolves a gas which remains trapped in the polymer mass. Upon heating, the polymer mass increases in volume by a factor of 6 to 8, yielding a product which it is believed may have good insulating properties (**4, 8**).

Halogenated plastics have a low resistance to radiation and undergo chain cleavage with evolution of fluorine and chlorine (**4**).

For Selectron 5038, plastics in group 8 to 10, and all plastics in group 12 except Teflon, elastic modulus, Rockwell hardness, tensile strength, and shear strength increased, but impact strength and elongation decreased and shortly the shear strength decreased. At about the same time the plastic cracked when the major load was applied in the Rockwell hardness test. Finally, all strength was lost and the plastic crumbled.

For the group 11 plastics the elastic modulus, Rockwell hardness, tensile strength, and shear strength decrease, but impact strength and elongation increase. Except for this same group where electrical properties decreased due to formation of hydrochloric acid as a decomposition product, as a rule no change occurred in volume resistivity or dielectric strength until mechanical properties deteriorated completely (**4**).

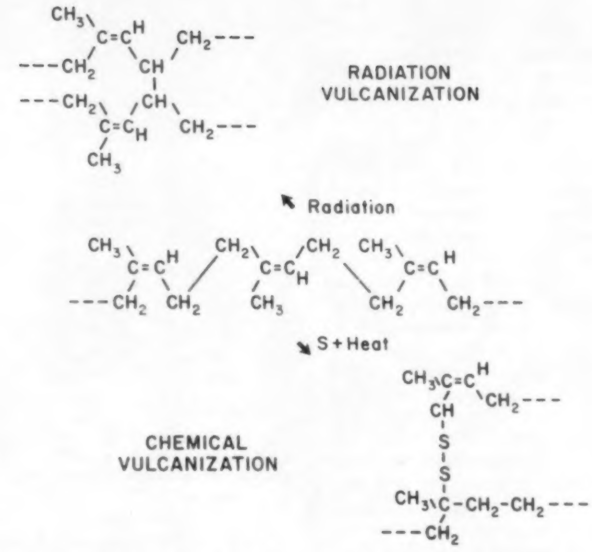

Fig. 11.—Vulcanization by chemical means and irradiation by gamma rays (from Reference (17)).

All of the transparent or translucent plastics tested which had not crumbled after 10^{18} nvt became very dark and light transmission decreased (**4**).

The radiation effect on some materials is influenced appreciably by the presence and type of fillers or modifiers (**4**). For example, mineral-filled phenolics (group 1) had higher radiation resistance than the cellulosic-filled (group 8) or unfilled phenolics (group 10).

It may also be observed that an improvement in one property is usually accompanied by a loss in another property. For example, the tensile strength increases but elongation decreases; impact strength may increase but the tensile strength will decrease; and elongation may increase at the expense of softening the material (**8**).

Graft Polymerization.—Radiation can, by free radical formation, initiate polymerization (**26**). Therefore, graft polymerizations are feasible and yield products either of the surface graft type (styrene onto Teflon) or of the bulk type (acrylonitrile in polyethylene) with unusual properties. However, many competing grafting techniques are available. Among these are mill polymerizations, grafting with ultrasonics, surface grafting by heating, peroxidation, and many others. Radiation graft polymerization is simply one technique among many, and it suffers the additional handicap of a high capital cost (**32**).

Other than the irradiation of materials by either ultraviolet light or electron beam to produce sterility, the only commercial irradiation process known to be successfully employed today is the cross-linking of polyethylene. General Electric Co.'s Irrathene and Tube Investment's electrical and packing tapes, General Electric Co's carbon filled polyethylene polymer (Vulkene), and Grace's polyethylene-coated wire are examples of products involving the use of radiation cross-linking. In this instance, less expensive photochemical or simple chemical cross-linking techniques are under development (**32**).

Effect on Elastomers

Elastomers always lose their elastomeric properties although some harden and some soften when irradiated. Butyl rubber becomes soft and gummy due to chain cleavage with resulting loss in tensile strength and elongation and a very large increase in compression set. Natural rubber becomes hard and brittle by cross-linking with a decrease in tensile strength, elongation, and compression set (**8**).

Vulcanization.—The radiation vulcanization of all the common elastomers, with the exception of butyl and Thiokol ST, has been reported by many investigators in the past few years. But radiation-cured materials with a few exceptions have not shown new or unique properties (**32**).

The size of exposure required eliminates the use of isotope radiation sources as a potential vulcanization tool for large scale production items such as tires (**32**).

One advantage of radiation vulcanization appears to be that curing can be accomplished without the use of those vulcanizing agents which may represent a real portion of the total materials cost of the conventionally cured stock (Fig. 11). In addition, cold vulcani-

zation of extruded materials can be realized and uniform cures may be obtained in thick items which are difficult to cure uniformly by chemical means. None of these advantages appear to counterbalance the high cost of these cures and the large capital investment necessary (**32**).

Effect on Lubricating Greases and Oils

In lubricating greases made with conventional soaps as gelling agents, gamma radiation severely damages the colloidal structure. First, the grease softens during exposures up to 1000 megareps as soap crystallites disintegrate. Metal and fatty acid ions discharge; metal migrates away from its normal site. Metallic and acidic fragments are badly separated and the acidic fragments possibly too oil-soluble to maintain a continuous crystallite network for strong gel structure. Also, at doses above about 1000 megareps grease hardens as oil polymerizes and cross links (**32**).

Since the portion of conventional greases most sensitive to radiation is the gelling agent, the use of specially synthesized alkylaromatic oils in lieu of conventional soaps as gelling agents has resulted in improved radiation resistance (**23**).

Radiation is known to cause increases in viscosity of organic fluids (**22**), with Fig. 12 showing viscosity change for base oils and Fig. 13 the industrial oils. Figure 14 illustrates increases in viscosity index of lubricating oils after irradiation (**22**). This effect was observed for all oils irradiated except for the automatic transmission fluid shown in Fig. 15. This fluid contained a high molecular weight polymer as a viscosity index improver. The initial decrease in viscosity was due to the breakdown of this polymer, which was accompanied and followed by the usual polymerization of the base oil. The dotted line, Fig. 15, represents the probable pattern of viscosity change. The steep slope after 5×10^8 r should be noted (**22**).

Those greases which showed pronounced changes in physical properties (Fig. 16) also showed a drastic change in fiber structure of the gelling agent. Figure 17 illustrates this change for the sodium soap grease.

Typical bearing life is shown in Fig. 18 for the industrial and the aircraft multipurpose greases. After 10^8 r, about 55 per cent and 80 per cent respectively of original bearing life was retained.

A survey by the California Research Corp. (**22**) of 28 off-the-shelf lubricants revealed the following gamma radiation resistance:

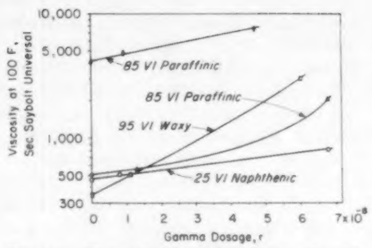

Fig. 12—Viscosity change of base oils with irradiation.

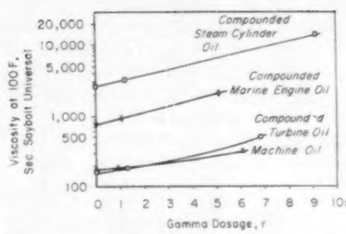

Fig. 13.—Viscosity change of industrial oils with irradiation.

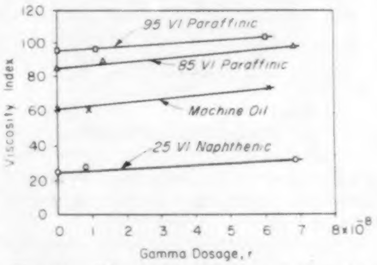

Fig. 14.—Effect of irradiation on viscosity index.

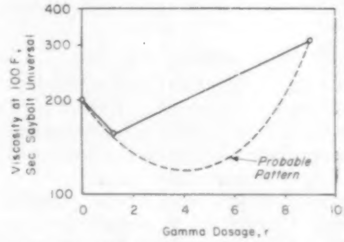

Fig. 15.—Radiation damage to a VI-improved automatic transmission fluid.

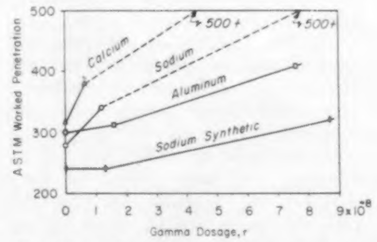

Fig. 16.—Effect of irradiation on grease consistency.

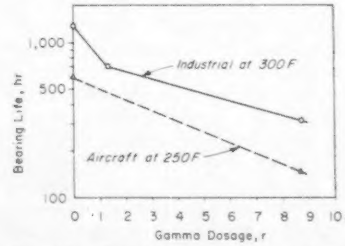

Fig. 18.—Effect of irradiation on bearing life of multipurpose greases.

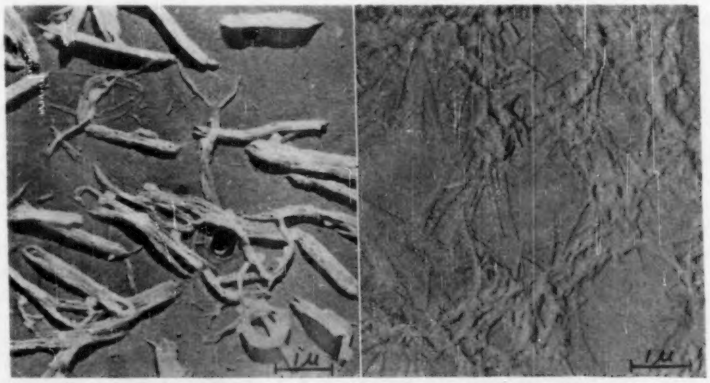

Fig. 17.—Effect of irradiation on a sodium soap grease (from Reference (22)).
Fresh grease Irradiated grease (7.7×10^8 r)

(*a*) Several commercial oils and greases can be used in the presence of gamma radiation for dosages of at least 10^8 r. Such products will probably provide the basic general purpose lubricants necessary for many of the lubricating requirements in nuclear power plants and accessory equipment.

(*b*) In general, the end effect of radiation on lubricants is similar to severe oxidation. Lubricants darken and acquire an acrid odor, oils show an increase in viscosity and greases show a marked change in consistency.

(*c*) The effect of radiation on compounding in lubricants in some cases is more significant in limiting their application than the effect on the bulk material. The release of hydrochloric acid from chlorinated extreme pressure

agents and the breakdown of polymeric viscosity index improvers illustrate this point.

(*d*) The wear properties and load carrying capacity of certain oils are enhanced by irradiation.

(*e*) Gamma irradiation improves the viscosity indexes of petroleum oils.

Inland Testing Laboratories reported in July, 1957 the beginning of a completely integrated dynamic research program on aircraft lubricants, fuels and hydraulic materials under cobalt-60 irradiation. Eleven specification materials are being tested (**31**).

Effect on Electronic Systems

Changes in electrical properties which result from intense radiation are of great theoretical and practical importance. These effects are immediately recovered in metals because of the large excess of electrons which exist in the metallic state. On the other hand, resistivity of the nonmetals is drastically reduced. Since many of our advanced weapons are so dependent upon electronic guidance and controls, involving accurate functioning of semiconductor and transistor devices, radiation damage is a most serious problem, especially since aircraft and missiles will not be able to pay the excessive weight penalties of complete shielding (**30**).

The study of electronic systems may be approached from three angles: namely (*a*) nuclear effects on materials, (*b*) nuclear effects on components, and (*c*) nuclear effects on over-all systems.

Most research has gone into effect on materials; components rate a poor second, and systems testing is almost nonexistent, mainly because of a lack of facilities (**30**).

Currently, several companies are conducting, under Wright Air Development Center contracts, extensive investigations on the effects of nuclear radiation on electronic components. Among the companies are Admiral, Convair, Cook Electric, and General Electric (**30**).

Being tested under gamma and neutron radiation are insulated wire, resistors, capacitors, electron tubes, semiconductor diodes and transistors, and printed circuit boards. The components were usually irradiated until they failed or some arbitrary flux level was reached (**30**). A typical integrated flux was 10^{18} thermal neutron per sq cm, 10^{18} gamma per sq cm and 2×10^{15} fast neutrons per sq cm. Temperature of components was 50 C and above (**35**). Time of irradiation was from 10 to 24 days.

Damage from nuclear radiation is a function of the type and energy distribution of the radiation, as well as of the other environmental factors such as heat, humidity, stress, and rate of irradiation. Generally, it can be divided into rate and integral effects. The former are a function of the intensity (flux density), or rate, of irradiation; the latter depends on the total dosage (that is, the time integral of the fluxes).

In the case of electronic parts, the type and extent of damage depends on the mode of operation and the material of which the part is made. Almost any part deteriorates under continued radiation (**30**).

Secondary effects can also take place. A component can fail not because of the radiation itself but rather because radiation has lowered its resistance to vibration, shock, heat, etc. (**30**).

Metal conductors have good radiation tolerance, and insulating materials now in use do not. Thus, the study of radiation damage to insulated wires and cables is largely a probing of insulation damage (**30**).

The resistivity of insulators generally decreases inversely with the intensity of the radiation field. A 99.9 per cent decrease is not uncommon in intense fields (**30**).

The d-c leakage, capacitance, and dissipation factor for wire pairs were measured. In testing wire-wound (precision and power) composition and deposited carbon as well as stannic oxide film type resistors, resistance to radiation has been found to vary markedly with manufacturer and type with the wire-wound resistors having excellent radiation tolerance. Some of the carbon film types tested showed an initial quick drop and then a gradual increase in resistance (**30**).

Capacitance and dissipation factor of capacitors have been measured during in-pile irradiation with mica, ceramic, glass, paper, and plastic dielectric types tested. Except for some temperature effects, capacitance varied only slightly with reactor power. The dissipation factor, however, was usually more sensitive (**30**).

Save for isolated cases, ceramic, mica, and glass dielectric types appeared quite radiation-resistant with changes generally less than 5 per cent (**30**).

Oil-impregnated paper types all showed both capacity and dissipation factor changes during the standard irradiation. As a rule, capacitance decreased while dissipation factor increased. One of the major problems with this type is that the radiation apparently causes the evolution of a gas which expands the capacitor plates, distorting and rupturing hermetically sealed units. Because of the expanding distance between plates, the capacitance decreased (**30**).

Plastic dielectric capacitors suffered an increase in dissipation factor and a final breakdown in dielectric (**30**).

Tests showed that as soon as radiation becomes apparent in electron tubes, they deteriorate rapidly. For example, it is not unusual for a tube to go from satisfactory to unsatisfactory operation in a matter of a few minutes (**30**).

The most common cause of failure found was seal deterioration, which let air into the tube envelope. Developing radiation-resistant tubes seems to be a matter of developing radiation-resistant glass. Some of the tubes that failed quickest under nuclear radiation contained boron in their glass (**40**).

All photosensitive devices are naturally sensitive to gamma radiation. Cathode-ray tubes survive but sustain a glass discoloration under constant irradiation (**30**).

It is fairly generally agreed that all semiconductors are vulnerable to nuclear radiation, with trace impurities producing large property changes (**16**). Three processes appear to occur simultaneously in the semiconductor exposed to nuclear radiation: (*a*) transmutation produced by capture of thermal neutrons, (*b*) Lattice disorder from elastic scattering of high energy neutrons, and (*c*) annealing (above 130 Kelvin).

It has recently been announced that it is now believed there is no difference in radiation tolerance between silicon and germanium. Originally, silicon was believed to be superior to germanium in this respect. Thus, the present limits of semiconductors in radiation fields appear to depend more on methods of manufacture than on the intrinsic properties of the units (**30**).

Conclusion

When nuclear fission reaction occurs, approximately 10 per cent of the released energy is given off as fission products, alpha and beta particles, gamma rays, neutrons, and a host of other products.

Materials most resistant to radiation include the common structural metals and ceramics; phenyl silane hydraulic fluids; and polyester, phenolic, and epoxide-phenolic structural plastics or adhesive.

Radiation quickly attacks such noncrystalline materials as most greases, lubricating and hydraulic oils, natural and synthetic rubbers and textiles. Among the more radiation-resistant of this group are natural rubber, mineral engine oil, MIL-L-7808 Anti-Rad hydraulic fluid, JP-5 fuel, Dacron fabric and two types of nylon webbing (type XIII OD and type VI OD), and leather. The olive drab used on the nylon webbing possibly acts as a radiation damage inhibitor (**18**). Because of this fact, where subject to nuclear radiation inorganics such as metal gaskets, seals, and couplings

along with dry lubricants are used in lieu of conventional materials.

Conclusions concerning radiation effects are tentative and are often reversed in the light of new findings. The threshold of damage seems to vary not only with the type of component but also among units of the same type made by different manufacturers. Extensive fundamental work is under way on this problem.

Although the mechanisms of irradiation are understood qualitively, there is no satisfactory quantitative theory available for engineering calculations (**17**).

Also, with the exception of a few materials, there is a lack of comprehensive experimental data on the effect of intense radiation on metals (**17**).

There is good experimental evidence that radiation will produce such beneficial changes in bulk properties of metals as are now obtained by conventional metallurigical methods (**17**).

Standard testing procedures and conditions appear to be greatly needed to permit correlation of results, especially relative to amount of radiation and temperature of exposure.

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A Preliminary Study of

Remote Fluoroscopy in the 2-Mev Range

By A. F. WEGENER and E. A. BURRILL

The use of a high-gain closed circuit television system for industrial fluoroscopic inspection in the 50 to 250-kvp range has been previously described. More recently, some preliminary studies of its performance in the 2-Mev range were undertaken. In spite of the usual low screen efficiency, penetrameter sensitivities of approximately 2 per cent for aluminum and 3 per cent for steel were obtained in some ranges.

INDUSTRIAL radiography in the 1 to 2-Mev range is now a routine procedure, and exhaustive studies have been made in the field of 1-Mev fluorography (**1**).[1] Fluoroscopy in this range has, however, never been seriously attempted for several reasons, the foremost being the protection problem. Performance of a closed circuit television system below 250 kvp has previously been reported (**2, 3**), and a thorough evaluation of this system was recently undertaken by McMaster (**4**). The following study covers its capabilities in the 2-Mev range and points to additional fields of application.

Screen intensifiers existing today have made definite contributions in the field of fluoroscopy below 150 or 250 kvp. However, they must compete with improved fluoroscopic techniques and equipment (**5, 6**) in this range. Beyond this range, protection problems increase and fluorescent screen efficiencies fall off. The remote viewing possibility and greater available amplification of a TV system become attractive under these circumstances.

Description of Equipment

The source of radiation was a 2-Mev Van de Graaff X-ray generator producing 75 r per min at 1 m (**7**). Its 1-mm spot focal was small enough to justify neglecting the calculation of minimum perceptible defect with the geometry used. The high radiation dosage delivered by this generator has a favorable effect on the resolution of the television system, since this resolution is a function of screen brightness.

A closed circuit television system using 1029 scann'ng lines and low noise high gain amplifiers (**2, 8**) was used. Figure 1 shows a block diagram of this system. The system itself is composed of a detector unit, incorporating the fluoroscopic screen, lens, television pick-

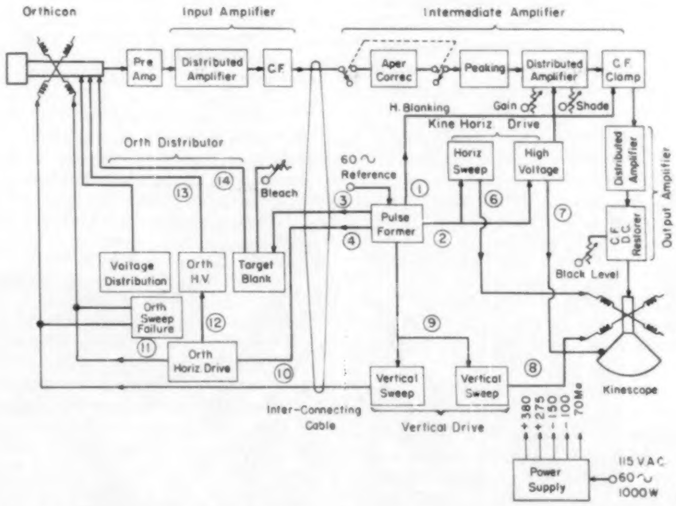

Fig. 1.—Block diagram of a 1029 line closed circuit television image intensifier using an Image Orthicon pickup tube.

ARTHUR F. WEGENER was Senior Engineer, Research and Advanced Development Laboratory of Bendix Aviation Corp. (Friez Instrument Division) when the work described here was performed. For the past 12 years he was associated with various phases of the industrial and medical X-ray field. He is presently with Machlett Laboratories, Inc., Springdale, Conn.

E. ALFRED BURRILL received his Bachelor of Science degree in Physics from MIT in 1943. He was research assistant at High Voltage Laboratory, MIT, from 1939 to 1947. In 1947 he went to High Voltage Engineering Corp., Burlington, Mass., where he now holds the position of Vice-President and Sales Manager.

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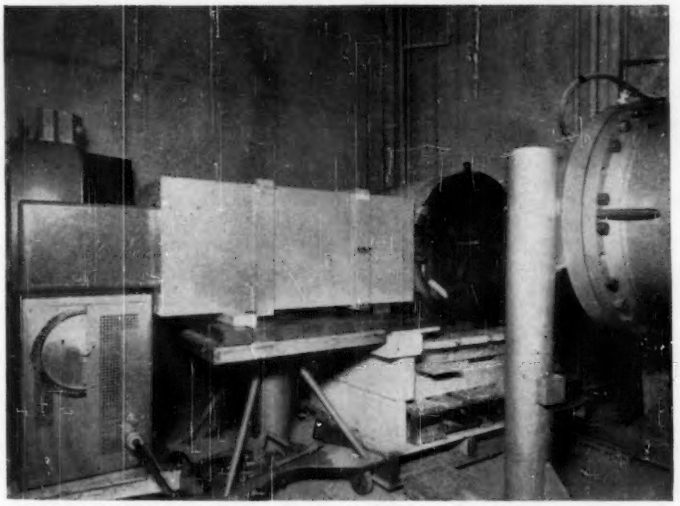

Fig. 2.—Experimental setup of a 2-Mev Van de Graaff generator (*right*) with target extending into casting to be examined for flaws, using the reflected X-ray beam. The center shows a lightproof extension tunnel in which a Patterson D 17 by 17-in. fluorescent screen is mounted on the right. The detecto: unit (*left*) houses a 45-deg front surfaced mirror in its light tunnel (*top*) and a $f/0.75$ lens system, Image Orthicon, preamplifier, and deflection circuits in the lower housing.

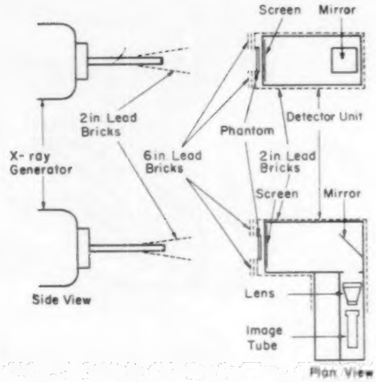

Fig. 3.—Physical arrangement used in the work described. The dotted lines represent a thickness of 2 in. of lead each; 6 in. of lead was used for attenuation of the primary beam in front of the detector while 2 in. of lead was used for scatter protection.

up tube, and input amplifiers; and a remote viewing console incorporating drive units, pulse former, and amplifiers as well as a 10-in. kinescope viewing tube. A "wide-spaced" Image Orthicon of the 6849 type and a 10UP14 semipersistence kinescope tube were used for the penetrameter investigations while a short persistance 10SP4 kinescope was used for the fluoroscopic screen brightness measurements.

Figure 2 shows the detector unit used in these tests. The fluoroscopic screen is viewed through a 45-deg front surface mirror designed to keep the primary radiation off the Orthicon tube and lens. Both a 10 by 10 in. and a 17 by 17 in. standard fluoroscopic screen were viewed at 28 and 64 in. from an $f/0.75$, 110-mm lens, using a wooden extension tunnel. The monitor unit was placed next to the X-ray control panel.

The effective resolution of the entire system is governed by the empirical formula:

$$\sqrt[3]{U_G^2 + U_S^2 + U_{TV}^2}$$

where:

U_G = the geometrical unsharpness,
U_S = the screen unsharpness, and
U_{TV} = the television system unsharpness.

With a 10 by 10 in. square kinescope viewing screen, the optimum television system resolution occurs when the vertical and horizontal line resolution is approximately equal. With a 1029 line scanning system, 103 lines are lost in retrace, leaving 926 theoretically available. Spreading these over a 10-in. viewing screen gives 92 lines per inch. At low contrast ratios and the usual inability to obtain the total theoretical resolution, this factor reduces to a minimum perceptible defect of somewhat less than $\frac{1}{32}$ in. On small objects, optical and X-ray magnification can improve this by three to five times.

Physical Layout

Figure 3 shows the relative positions of the X-ray generator target (only transmitted radiation was used) and the intensifier monitor. A standard 10 by 10-in. fluorescent screen and a special 17 by 17-in. screen, mounted on a special lightproof extension, were used to determine influence of field size on resolution. In both cases the field size represented the limit of the useful field of the f/0.75 lens.

The target of the 2-Mev X-ray tube was shielded by lead on all sides, leaving only a portal large enough to cover the screen with transmitted radiation. The screen itself was shielded by 6-in. lead bricks except for the useful (phantom) area. This provided an attenuation to about 20 per cent. To eliminate back scatter from the walls behind the unit, most of the camera unit was encased in 2 in. of lead bricks. With this arrangement the secondary radiation was elim-

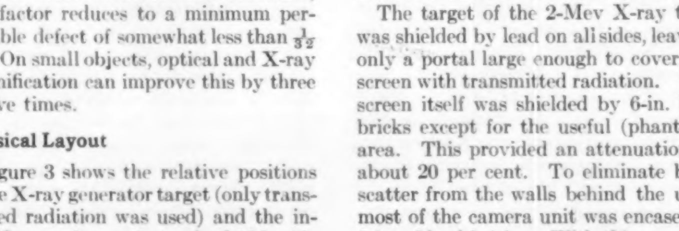

Fig. 4.—Penetrameter sensitivities obtained under the conditions shown in Fig. 3. An improvement of penetrameter sensitivity was noted from 0 to $\frac{1}{4}$, in. lead between object and screen but further increase of filter thickness resulted in loss of sensitivity. Dotted lines show extrapolations.

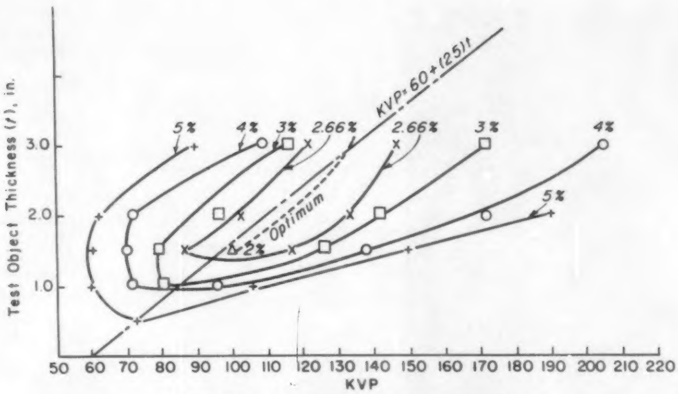

Fig. 5.—Summary of penetrameter sensitivities obtained in the low and medium kilovoltage range, as a function of aluminum thickness (24S).

inated for all practical purposes. More refined shielding was not possible due to the limited time available. With the possible use of lead-copper-aluminum sandwiches, the scatter protection could be brought down to a much more desirable weight and volume.

Radiation Dose

Since the Van de Graaff generator produces approximately 75 r per min at 1 m, the calculated dose rate at 24 in. target-to-screen distance (TSD) was 202 r per min and at 16 in. TSD, 450 r per min. With a frame repetition rate of 30 per sec this, in turn, represents a television frame exposure of 112 and 250 mr per frame. This is an extremely high dose rate if one considers that perceptible images can still be produced with this system at 0.028 mr (80 kvp, 5 mr per min) (**2**) per frame.

The efficiency of zinc-cadmium sulfide screens in the 2-Mev region is quite poor compared to that attainable in the low kilovoltage range normally used. While the maximum efficiency of such a screen is approximately 30 per cent at 140 kv, it is estimated to be in the order of a few per cent at 2 Mev (**10**). Since the production of light photons in a transducer is inversely proportional to the wavelength ratios, the screen is, in effect, more sensitive to the longer wavelength scatter radiation than to the primary radiation. However, due to the high dose rate used and good scatter control, the results were encouraging.

Penetrameter Sensitivities

Figure 4, for steel and aluminum, respectively, demonstrates the penetrameter sensitivities obtained under the conditions previously described. Figure 5 has been added to allow comparison of the performance of the system on aluminum in the 100 to 200-kv range.

Penetrameter sensitivity improves measurably as material thickness increases, provided there is sufficient primary beam energy, since it is no longer limited by the minimum detail a television system can reproduce.

Target-to-screen distances of 16 and 24-in. were used. Two different screen sizes were used to determine the relative effect of lens resolution and distance on over-all performance. Essentially the same penetrameter sensitivities were obtained throughout the range of material thicknesses investigated with slight evidence that the greater screen-to-lens distance improved the sensitivity somewhat. This may be because the eye can more readily discern contrast differences when the density edges are sharp. It should be remembered, however, that the minimum perceptible defect increases at larger lens-to-screen distances.

Throughout the tests two observers were used, one with very little experience and the other an experienced X-ray technician. Their observations agreed well.

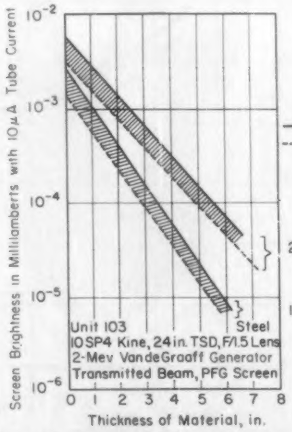

Fig. 6.—Screen brightness obtained at 10-μa tube current, at 1.5 and 2 Mev, as a function of steel thickness.

Penetrameters in accordance with Military Specification MIL-1-6865A were used. Since penetrameters were available only in ½-in. steps, a certain amount of interpolation was done but, without exception, on the conservative side. The points shown in Figs. 4 and 5 were obtained from conditions when all three holes were visible. Where interpolation was used, the method proposed by qualified workers in the field was used (**9**). The data fell in line quite well.

Screen Brightness Measurements

Since the resolution of the system is a predictable function of input light level, this characteristic of a TV system can be useful for measuring screen brightness or other applications where the brightness of an object cannot be measured by direct means.

The authors used this characteristic for the determination of fluoroscopic screen brightness at 1.5, 1.75, and 2 Mev as a function of material thickness interposed. Figures 6 and 7 show the brightness of a standard zinc-cadmium sulfide screen (U. S. Radium, type PFG) with a tube current normalized to 10 μa. Thus the respective dose rates at the screen were 8.0 mr per min for a 24-in. target-to-screen distance or a single frame dosage of 0.266 mr.

These results were obtained by mounting a 100 per cent contrast negative of a double size 25× National Bureau of Standards resolution chart in contact with the screen (lens side). The maximum number of lines discernible was read on the kinescope and the result referred back to effective brightness in millilamberts.

Summary

The data obtained appear encouraging, and the equipment combination is promising. The authors are planning further efforts in this field.

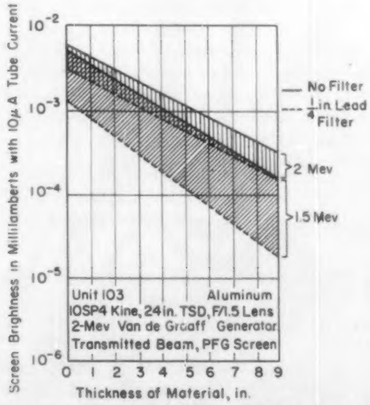

Fig. 7.—Screen brightness obtained with 10-μa tube current at 1.5 and 2 Mev, as a function of aluminum thickness.

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Hydraulic Cement for Water Tanks and Pipe Lines

By W. C. HANSEN

Studies were made with mortars of three samples of type I portland cement and three samples of type IS portland-blast-furnace slag cement to demonstrate the rates at which CaO, Na_2O, and K_2O would be leached from water-carrying pipe lines and water tanks lined with concrete made with these cements. The results of the study show a slight superiority for type IS cement over type I portland cement for this type of service.

The cement industry is often asked to recommend the cement most suitable for lining water-carrying pipe lines and domestic hot water tanks. Since portland-blast-furnace slag cements (type IS) have become available, the nature of this question has changed to include the question as to whether or not the type IS cement is suitable for this use.

This investigation was undertaken to obtain data which could be used in answering these questions. Before considering the experimental data, it is helpful to consider the problem from the standpoint of the chemical reactions which occur when concrete is acted upon by water.

The principal components of portland and portland-blast-furnace slag cements are as follows (**1**):[1] (1) $3CaO \cdot SiO_2$ or $54CaO \cdot 16SiO_2 \cdot MgO \cdot Al_2O_3$, (2) $2CaO \cdot SiO_2$ or $23\ CaO \cdot K_2O \cdot 12SiO_2$, (3) $3CaO \cdot Al_2O_3$, (4) $8CaO \cdot Na_2O \cdot 3Al_2O_3$, (5) SS[2]-$2CaO \cdot Fe_2O_3$-$6CaO \cdot 2Al_2O_3 \cdot Fe_2O_3$, (6) SS-$K_2SO_4$-$Na_2SO_4$, (7) MgO, (8) $CaSO_4 \cdot 2H_2O$, (9) Glass, and (10) Blast-furnace slag glass.

Normally, the principal compound in portland cement is considered to be $3CaO \cdot SiO_2$. However, recent work has indicated that it contains some MgO and Al_2O_3 and its composition approaches that of $54CaO \cdot 16SiO_2 \cdot MgO \cdot Al_2O_3$. From the standpoint of the behavior of concrete to leaching by water, we need not be concerned with all of the components in cement nor with the minor amounts of foreign oxides that might be present in some of them. We can limit this to the following more or less simple phases: $3CaO \cdot SiO_2$; $23CaO \cdot K_2O \cdot 12SiO_2$; $8\text{-}CaO \cdot Na_2O \cdot 3Al_2O_3$; K_2SO_4; Na_2SO_4; $CaSO_4 \cdot 2H_2O$; and blast-furnace slag.

In cement pastes, these are believed to react about as follows:

$$2(3CaO \cdot SiO_2) + 6H_2O = 3CaO \cdot 2SiO_2 \cdot 3H_2O + 3Ca(OH)_2$$

$$23CaO \cdot K_2O \cdot 12SiO_2 + 24H_2O = 6(3CaO \cdot 2SiO_2 \cdot 3H_2O) + 5Ca(OH)_2 + 2KOH$$

$$8CaO \cdot Na_2O \cdot 3Al_2O_3 + Ca(OH)_2 + 18H_2O = 3(3CaO \cdot Al_2O_3 \cdot 6H_2O) + 2NaOH$$

$$3CaO \cdot Al_2O_3 \cdot 6H_2O + 3CaSO_4 + 25H_2O = 3CaO \cdot Al_2O_3 \cdot 3CaSO_4 \cdot 31H_2O$$

$$3CaO \cdot Al_2O_3 \cdot 6H_2O + 3M_2SO_4 + 3Ca(OH)_2 + 25H_2O = 3CaO \cdot Al_2O_3 \cdot 3CaSO_4 \cdot 31H_2O + 6MOH$$

Note: M = either Na or K.

There is some evidence (**2**) that $3CaO \cdot 2SiO_2 \cdot 3H_2O$, when formed in solutions of NaOH and KOH, may contain some Na_2O and K_2O, probably in solid solution.

The reaction of blast-furnace slag glass in the pastes of type IS cement is not known. However, it is believed that the glass tends to form the same reaction products that the portland cement compounds do. The CaO contents of these slags are not sufficient to yield $3CaO \cdot Al_2O_3 \cdot 6H_2O$ and $3CaO \cdot 2SiO_2 \cdot 3H_2O$ without taking up $Ca(OH)_2$ from the cement. Hence, it is believed that the slag reacts with water first to form compounds less basic than $3CaO \cdot Al_2O_3$ and $3CaO \cdot 2SiO_2$ but that these less basic compounds tend gradually to take up $Ca(OH)_2$ to form the more basic compounds.

W. C. HANSEN, director of research, Universal Atlas Cement Co., received his Ph.D. in physical chemistry from Columbia University. He conducted research on the constitution of portland cement at the National Bureau of Standards in Washington, D. C., and on portland cement concrete in Chicago while employed by the Portland Cement Association and has published many papers in these fields. He has been associated with the Universal Atlas Cement Co. since January, 1945.

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[1] The boldface numbers in parentheses refer to the list of references appended to this paper.

[2] SS denotes solid solution of compounds indicated.

TABLE I.—COMPOSITIONS OF CEMENTS.*

Cement	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	MnO	SO_3	Loss	S	K_2O	Na_2O	Total Alkalies
PLANT A												
Type I.........	20.5	6.8	2.8	63.4	2.9	0.47	1.7	0.89	...	0.40	0.13	0.53
Type IS........	25.7	9.1	2.6	53.2	4.4	0.70	2.0	1.4	0.72	0.55	0.21	0.76
PLANT B												
Type I.........	20.8	5.5	3.1	63.4	3.0	0.57	1.8	1.6	0.08	0.16	0.10	0.26
Type IS........	27.3	6.1	3.3	54.3	3.3	0.72	2.2	2.1	0.60	0.20	0.09	0.29
PLANT C												
Type I.........	20.7	6.7	2.5	63.1	2.8	0.15	2.0	0.85	...	0.83	0.38	1.21
Type IS........	28.8	8.0	2.5	55.1	2.5	0.35	2.0	1.4	0.45	0.62	0.26	0.88

Note: The cement IS cement from Plant C was made experimentally for this investigation. Those from Plants A and B and the three type I cements are commercial products.

From the above, it is seen that the principal products from the reaction of either portland cement or portland-blast-furnace slag cement with water are: (1) $3CaO \cdot 2SiO_2 \cdot 3H_2O$, (2) $3CaO \cdot Al_2O_3 \cdot 6H_2O$, (3) $3CaO \cdot Al_2O_3 \cdot 3CaSO_4 \cdot 31H_2O$, (4) $Ca(OH)_2$, and (5) MOH (NaOH and KOH).

The first four are relatively insoluble in water, and NaOH and KOH are highly soluble. The first three are not stable in pure water but decompose as follows:

$$3CaO \cdot 2SiO_2 \cdot 3H_2O = 2H_2SiO_4 + 3Ca(OH)_2$$

$$3CaO \cdot Al_2O_3 \cdot 6H_2O = 2Al(OH)_3 + 3Ca(OH)_2$$

$$3CaO \cdot Al_2O_3 \cdot 3CaSO_4 \cdot 31H_2O = 2Al(OH)_3 + 3Ca(OH)_2 + 3CaSO_4 \cdot 2H_2O$$

The reactions of these compounds and water is known as hydrolysis. If a sample of any of them is placed in pure water, hydrolysis proceeds until the concentration of $Ca(OH)_2$ in solution reaches a value which prevents further hydrolysis. If this solution is replaced with fresh water, the reaction is resumed. The silicic acid ($H_2SiO_4 \cdot xH_2O$) and the hydrated alumina $Al(OH)_3$ are much less soluble than $Ca(OH)_2$. Hence, continued leaching with fresh water carries away all of the $Ca(OH)_2$ and leaves the SiO_2 and the Al_2O_3 behind.

The alkalies in portland-cement clinker that are combined as sulfates are very readily soluble (**3**) and dissolve within a few minutes after the cement is mixed with water. Compounds, such as $23CaO \cdot K_2O \cdot 12SiO_2$ and as $8CaO \cdot Na_2O \cdot 3Al_2O_3$, react slowly with water in the cement pastes, and the alkalies in them are released to water during the period of time required for complete reaction of these compounds with water. Hence, a portion of the alkalies are readily leached from new concrete products and a portion is leached at a relatively slow rate.

TABLE II.—COMPOSITION OF MORTARS.

Cement	Cement, g	Sand, g	Water, ml	Cement, per cent	Weight of Three 2-in. Cubes, g
PLANT A					
Type I....	500	500	146	43.6	893
Tye IS....	500	500	154	43.3	885
PLANT B					
Type I....	500	500	160	43.1	883
Type IS...	500	500	155	43.3	870
PLANT C					
Type I....	500	500	157	43.3	890
Type IS...	500	500	156	43.3	886

TABLE III.—RESULTS OF EXTRACTION TESTS.

Extraction Period, days	Total Days of Extraction	Cumulative Grams CaO Extracted from Three Mortar Cubes of the Cement Indicated: PLANT A, Type I	PLANT A, Type IS	PLANT B, Type I	PLANT B, Type IS	PLANT C, Type I	PLANT C, Type IS
1.....	1	0.23	0.21	0.26	0.34	0.13	0.30
1.....	2	0.43	0.34	0.48	0.56	0.29	0.49
3.....	5	0.57	0.45	0.62	0.70	0.38	0.58
1.....	6	0.64	0.61	0.71	0.76	0.46	0.64
1.....	7	0.71	0.66	0.81	0.83	0.54	0.70
1.....	8	0.79	0.71	0.89	0.89	0.61	0.74
1.....	9	0.86	0.75	0.95	0.93	0.67	0.78
3.....	12	0.96	0.82	1.05	1.00	0.76	0.84
1.....	13	1.01	0.85	1.11	1.04	0.81	0.87
1.....	14	1.06	0.89	1.17	1.08	0.87	0.90
1.....	15	1.10	0.92	1.22	1.11	0.92	0.93
1.....	16	1.15	0.95	1.28	1.14	0.98	0.96
3.....	19	1.22	1.00	1.37	1.20	1.06	1.01
1.....	20	1.26	1.03	1.42	1.23	1.10	1.04
1.....	21	1.30	1.05	1.46	1.26	1.14	1.06
1.....	22	1.34	1.07	1.51	1.28	1.18	1.08
1.....	23	1.38	1.10	1.56	1.31	1.23	1.10
11.....	34	1.50	1.19	1.70	1.39	1.37	1.17
3.....	37	1.60	1.26	1.83	1.46	1.47	1.23
7.....	44	1.69	1.33	1.93	1.52	1.57	1.29
17.....	61	[a]	[a]	[a]	[a]	[a]	[a]
14.....	75	1.79	1.41	2.04	1.59	1.67	1.36
21.....	96	1.90	1.49	2.16	1.68	1.77	1.43

[a] Not determined.

When a specimen of concrete is immersed in water, the alkalies that have been released from the cement minerals tend to diffuse from the liquid phase of the cement paste into the surrounding water. At the same time, the calcium-bearing phases tend to hydrolyze and saturate the water with $Ca(OH)_2$.

Experimental

Type I cements from three plants and type IS cements made from the

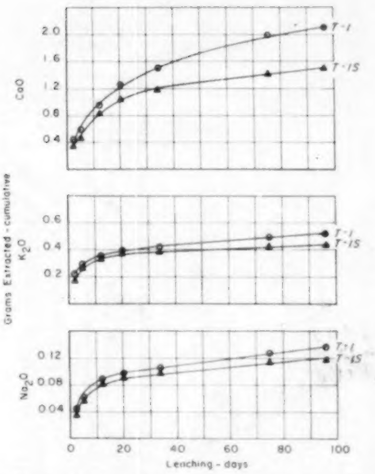

Fig. 1.—Grams extracted *versus* days of leaching for cements from plant A.

type I portland-cement clinker from these plants were used in this study. The compositions of the cements are given in Table I.

The cements were made into 2-in. mortar cubes in the proportion of one part cement to one part minus 48 sieve Ottawa sand. Leaching of such a specimen immersed in water would be equivalent approximately to leaching a lining 1 in. thick. The compositions of the mortars are given in Table II.

Three cubes of a kind, cured for 24 hr in a moist cabinet, were suspended in deionized water in beakers that were sealed with polethylene membranes to protect the solution from carbon dioxide. For about the first three weeks, the water was changed each day, except for weekends, when the leaching period was three days. Later, longer leaching periods were used. The total leaching time was 96 days.

The solutions removed at each leaching period were analyzed for CaO, K_2O, and Na_2O (Tables III, IV, and V). Table III gives the data for CaO and Tables IV and V those for K_2O and Na_2O, respectively. Data at the bottoms of Tables IV and V show the compositions of the cubes with respect to cement, K_2O, and Na_2O. Also, the data in these tables show the per cent of the K_2O and Na_2O in the cubes that was extracted in 96 days.

Discussion of Results

The data for plant A are plotted in Fig. 1. Those for the cements from the other plants would give similar plots.

These plots show that there is a relatively rapid rate of leaching of CaO, K_2O, and Na_2O for about the first ten days. This rate then drops to a relatively low rate which tends to decrease with time.

TABLE IV.—RESULTS OF EXTRACTION TESTS.

Extraction Period, days	Total Days of Extraction	Cumulative Grams K_2O Extracted from Three Mortar Cubes of the Cement Indicated					
		Plant A		Plant B		Plant C	
		Type I	Type IS	Type IS	Type IS	Type I	Type IS
1	1	0.153	0.112	0.060	0.031	0.120	0.138
1	2	0.218	0.170	0.089	0.049	0.193	0.210
3	5	0.288	0.255	0.118	0.075	0.294	0.306
1	6	0.301	0.271	0.123	0.082	0.317	0.324
1	7	0.311	0.285	0.126	0.086	0.335	0.340
1	8	0.320	0.295	0.129	0.090	0.351	0.352
1	9	0.329	0.305	0.132	0.093	0.365	0.362
3	12	0.350	0.327	0.141	0.103	0.399	0.383
1	13	0.355	0.332	0.142	0.104	0.409	0.389
1	14	0.360	0.336	0.143	0.105	0.419	0.393
1	15	0.365	0.341	0.145	0.107	0.428	0.397
1	16	0.370	0.346	0.148	0.109	0.437	0.402
3	19	0.386	0.358	0.153	0.113	0.464	0.412
1	20	0.391	0.361	0.154	0.114	0.471	0.415
1	21	0.396	0.364	0.155	0.115	0.479	0.418
1	22	0.400	0.367	0.157	0.116	0.486	0.420
1	23	0.403	0.369	0.158	0.116	0.494	0.421
11	34	0.423	0.379	0.167	0.121	0.526	0.430
3	37	0.436	0.386	0.172	0.122	0.553	0.434
7	44	0.447	0.394	0.180	0.123	0.576	0.438
17	61	0.470	0.407	0.194	0.131	0.627	0.448
14	75	0.491	0.417	0.205	0.135	0.670	0.456
21	96	0.519	0.432	0.225	0.140	0.735	0.464
Per Cent of Total K_2O Removed in 96 Days		33	20	37	19	23	19
3 Cubes							
Weight of 3 Cubes, g........		893	885	883	870	890	886
Grams Cement in 3 Cubes...		389	383	381	377	385	384
Grams K_2O in 3 Cubes......		1.56	2.11	0.61	0.75	3.20	2.38
Grams Na_2O in 3 Cubes.....		0.51	0.80	0.38	0.34	1.46	1.00

This decrease in the rate of leaching appears to be explainable in terms of the nature of the products produced by the hydrolysis of the calcium silicates and aluminates. The tendency is for the CaO to be leached completely from the surface of the specimen and to leave gelatinous silicic acid and hydrated alumina in place of the calcium silicates and aluminates. The thickness of this leached material increases with time of leaching. It is necessary for the leaching water to diffuse through this gelatinous coating to reach and attack the underlying silicates and aluminates. Likewise, it is necessary for the ions of calcium, sodium, and potassium released from the underlying phases to migrate through this gelatinous material to reach the leaching water. Therefore, the controlling factor in the leaching process very soon becomes the permeability of this gelatinous coating to water and ions of calcium, sodium, and potassium.

The leaching of the alkalies may be compared as follows:

Plant	Cement	Alkalies in Cubes From Cement, per cent		Alkalies Leached From Cubes in 96 days, g		Alkalies Extracted in 96 days, per cent of total in cement	
		K_2O	Na_2O	K_2O	Na_2O	K_2O	Na_2O
A.......	Type I	1.56	0.51	0.519	0.138	33	27
	Type IS	2.11	0.80	0.432	0.118	20	15
B.......	Type I	0.61	0.38	0.225	0.135	37	36
	Type IS	0.75	0.34	0.140	0.118	19	35
C.......	Type I	3.20	1.46	0.735	0.351	23	24
	Type IS	2.38	1.00	0.464	0.224	19	22

These data show that, with the cements from plants A and B, the substitution of slag for clinker increased the alkali contents of the cement. However, less alkali was leached from the type IS cements than from the type I cements. This indicates that the alkalies in the slag are much less readily leachable than are those from the clinker. This may indicate that the alkalies from the slag tend to be held in solid solution in the $3CaO \cdot 2SiO_2 \cdot 3H_2O$.

Substitution of slag for clinker reduced the CaO content of the cement from approximately 65 to 54 per cent. This reduction in CaO content is reflected (see Fig. 1 and Table III) in the rate at which CaO is leached from the specimens.

From the standpoint of practice, the results of this study show that pipes and tanks lined with mortars made of either portland or portland-blast-furnace slag cements should be filled with water, allowed to stand for a few days, and then drained to remove those alkalies that are readily available for leaching

and to put the lining in a condition in which leaching of alkalies and calcium hydroxide occurs at a slow rate. Two or three such washings with periods of a few days between each draining would be desirable.

The data indicate that type IS cement is likely to be superior to type I portland cement for mortar in this type of service.

Acknowledgment:

The author takes pleasure in acknowledging the assistance of his colleagues who performed the experimental work in this study and assisted in preparing this paper.

TABLE V.—RESULTS OF EXTRACTION TESTS.

Extraction Period, days	Total Days of Extraction	Cumulative Grams of Na_2O Extracted from Three Mortar Cubes of the Cement Indicated					
		Plant A		Plant B		Plant C	
		Type I	Type IS	Type I	Type IS	Type I	Type IS
1.....	1	0.031	0.026	0.027	0.022	0.044	0.065
1.....	2	0.044	0.034	0.043	0.035	0.073	0.101
3.....	5	0.062	0.057	0.061	0.053	0.122	0.150
1.....	6	0.071	0.060	0.064	0.056	0.132	0.158
1.....	7	0.074	0.064	0.067	0.059	0.140	0.165
1.....	8	0.077	0.068	0.069	0.062	0.145	0.169
1.....	9	0.080	0.072	0.072	0.065	0.152	0.174
3.....	12	0.089	0.080	0.079	0.072	0.170	0.184
1.....	13	0.090	0.081	0.080	0.073	0.175	0.187
1.....	14	0.091	0.082	0.081	0.074	0.179	0.187
1.....	15	0.092	0.083	0.082	0.075	0.186	0.189
1.....	16	0.093	0.084	0.083	0.076	0.193	0.191
3.....	19	0.096	0.090	0.088	0.099	0.207	0.197
1.....	20	0.097	0.091	0.089	0.100	0.210	0.198
1.....	21	0.098	0.092	0.089	0.101	0.215	0.199
1.....	22	0.099	0.093	0.089	0.101	0.219	0.200
1.....	23	0.099	0.093	0.089	0.101	0.222	0.200
11.....	34	0.106	0.098	0.096	0.105	0.240	0.205
3.....	37	0.110	0.102	0.101	0.107	0.257	0.209
7.....	44	0.115	0.106	0.105	0.108	0.270	0.213
17.....	61	0.123	0.111	0.114	0.112	0.296	0.217
14.....	75	0.128	0.115	0.122	0.115	0.316	0.221
21.....	96	0.138	0.118	0.135	0.118	0.351	0.224
Per Cent of Total Na_2O Removed in 96 Days..........		27	15	36	35	24	22
3 Cubes							
Weight of 3 Cubes, g..........		893	885	883	870	890	886
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Grams Na_2O in 3 Cubes......		0.51	0.80	0.38	0.34	1.46	1.00

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A Comparison of

Cement Strengths in Mortars and Concretes*

By MYRON A. SWAYZE[1]

IN JUNE 1956 the Lone Star Cement Research Laboratory at Hudson, N. Y., started a large program of tests to obtain comprehensive data on some 70 sources of portland cement made at the 15 domestic and 6 foreign plants of the corporation. The test schedule included all of the ASTM chemical and physical tests on cements, pastes, and mortars, as well as such items as heat of hydration and sulfate resistance. All tests were made in three rounds, usually on successive days. Mortar strength tests were made at 1, 3, 7, 28, 91, and 365 days, with nine breaks for each age, except for modified 40-mm cubes which yield 18 breaks.

A wide range of concrete mixes were included. Cement contents of 3.6, 4.5, 6.0, 7.5, and 9.0 sacks per cu yd, using sand-gravel aggregates graded from 0 to $1\frac{1}{2}$ in. were mixed to consistencies of 2 in. and 6-in. slump. Batches were 2.40 cu ft in volume, mechanically mixed. Sand-gravel proportions for each cement content were calculated by the total fineness modulus method (ACI-March, 1947). For plain concrete, a total-fineness modulus of 4.85 was used. When cements were air entraining, the total fineness modulus was raised to 5.00. Test ages were the same as for mortar strength specimens, except for flexural strength of concrete beams, which were made for test at 1, 3, 7, and 28 days only. Three rounds of tests were made for each mix, slump and test age. Each cement required the mixing of 60 batches of concrete, from which were cast 300 to 330 6 by 12-in. cylinders, sixty 6 by 6 by 30-in. beams and sixty 3 by 3 by 10-in. bars for volume change measurements. Testing of each cement work to prepare specimens and consumed approximately 36 sacks of cement.

Molding of cylinders and concrete beams were in accord with ASTM

M. A. Swayze, Director of Research, Lone Star Cement Corp., New York, N. Y. A graduate of Case Institute of Technology, Cleveland, Mr. Swayze is an outstanding authority in field of cement, concerned for many years particularly with testing and research problems. He has been abroad on numerous occasions in the interest of cement technology and was selected by our Government in 1945 to conduct a survey of the German cement industry at the end of the second World War for the Foreign Economic Administration.

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[1] Director of Research, Lone Star Cement Corp., New York, N. Y.

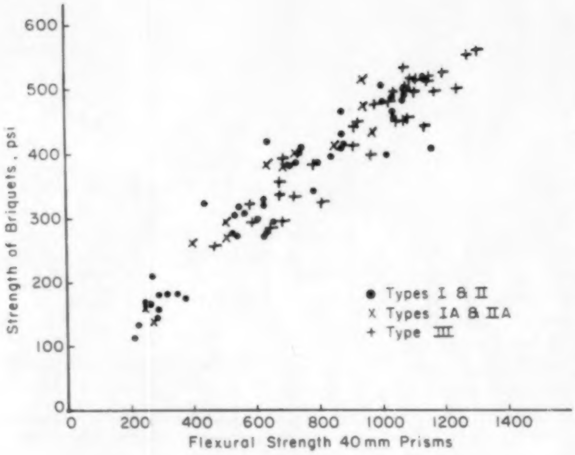

Fig. 1.—Flexural strength, prisms *versus* briquets.

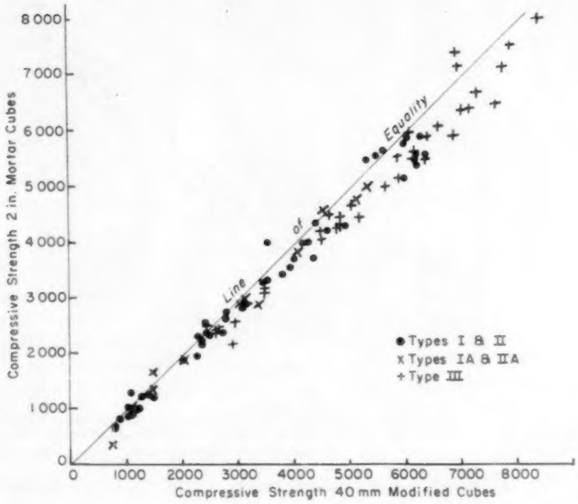

Fig. 2.—Compressive strength, modified cubes *versus* mortar cubes.

Method C 192[2] except that extra spading of concrete in the beam molds was used to supplement the 60 rodding tamps specified per layer. Even this procedure failed to yield uniform beam breaks, which were made by center loading. Beam breaks of concrete with 6-in. slump frequently were equal to or higher than otherwise identical concrete mixed to a 2-in. slump. Occasionally, beams with 9.0-sack concrete showed lower strengths than those with 7.5-sack concrete, which we attribute largely to poorer compaction, with weak pieces of coarse aggregate as a minor contributing cause.

We believe we have recently remedied these troubles by use of an internal vibrator for all 6, $7\frac{1}{2}$, and 9-sack mixes of 2-in. slump and for the $7\frac{1}{2}$ and 9-sack mixes with 6-in. slump. Concrete flexural strengths are now more uniform and have better relationship to the corresponding compressive strengths. Unit weights as determined in a $\frac{1}{2}$-cu ft measure have also increased under vibration.

Since the concrete flexural tests of the first 24 cements tested in our program were hand tamped and therefore not reliable, the results have been omitted from the data here presented. The compressive strengths of concrete cylinders shown for each cement for the 1, 3, 7, and 28-day test ages are averages of all concrete specimens made with 4.5, 6.0, and 7.5 sacks per cu yd and both 2 in. and 6-in. slumps—a total of 18 specimens. Mortar strengths are averages of 9 specimens.

Figure 1 shows the relation between tensile strengths of briquets and flexural strengths of 40-mm prisms for six type I cements, six type II, three type IA and IIA, and nine type III cements. A moderately good relationship is evident with a few sports above and below the general pattern. As should be expected from knowledge of brittleness and abnormal stresses in briquets with increasing age, the strength ratios between flexure and tension increase with age.

Figure 2 gives the relation between strengths of 2-in. cubes and modified 40-mm cubes. Agreement is excellent, with the modified cubes showing slightly higher strengths, which should be expected from their smaller size. Both

RATIO OF FLEXURAL TO TENSILE STRENGTHS.

Cement	1 day	3 days	7 days	28 days
12 types I and II	1.69	1.88	1.91	2.19
3 types IA and IIA	1.63	1.74	1.80	1.97
9 type III	2.03	2.06	2.18	2.21

RATIO OF MODIFIED CUBE TO 2-IN. CUBE STRENGTHS.

Cement	1 day	3 days	7 days	28 days
12 types I and II	1.14	1.05	1.06	1.07
3 types IA and IIA	1.11	1.01	1.10	1.04
9 type III	1.12	1.10	1.08	1.08

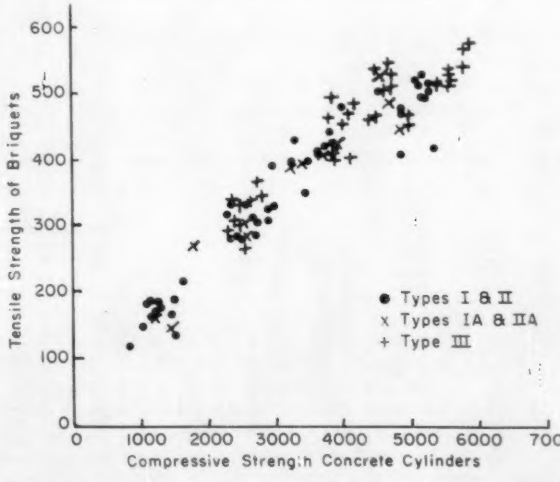

Fig. 3.—Compressive strength, concrete cylinders *versus* tensile strength, briquets.

[2] Method of Making and Curing Concrete Compression and Flexure Test Specimens in the Laboratory (C 192 – 55), 1955 Book of ASTM Standards, Part 3, p. 1318.

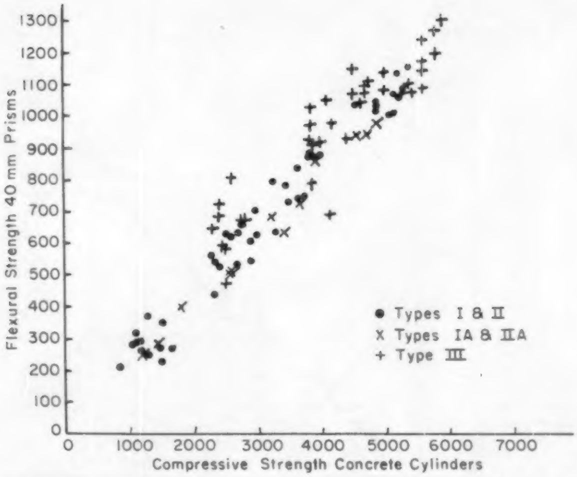

Fig. 4.—Compressive strength, concrete cylinders *versus* flexural strength, prisms.

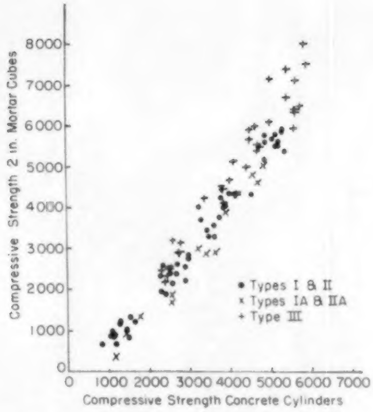

Fig. 5.—Compressive strength, concrete cylinders *versus* mortar cubes.

types of specimens were made with the same type of mortar and, with only two exceptions, the same percentage of water.

Coming to comparisons of strengths of the various mortar tests with the compressive strengths of concrete, Fig. 3 shows the relation between briquet strengths and concrete strengths. Again, there is a moderately good relation between briquets and concrete strengths, with no apparent advantage for any type of cement. An interesting sidelight is to note how closely the 2½-hr strengths of type III cements compare with the 3-day values of types I and II modern products.

Figure 4 giving comparable flexural strengths of 40-mm prisms and concrete compressive strengths shows practically the same spread of results as did the briquet-concrete data, but with this subtle difference. Whereas the briquet made no distinction between types, the flexural strength test does so. Air-entrained concrete strengths tend to be below the median line, while type III cement concrete strengths range slightly above it. The underestimation of air-entrained concrete strengths by the flexure test is largely due to the different concrete mix, in which sand contents were reduced to compensate for extra air. If all concretes had been made with the same sand-gravel proportions, the air-entrained concretes would have had no advantage.

The slight overestimation of type III cement concrete strengths by the flexural breaks of prisms is largely a matter of comparable water-cement ratios. Our European friends in the cement testing field tell us that our standard plastic mortar is not plastic and have some data that indicates it. The data in Table I lead to the same conclusion. Note that for type I and II cements of normal fineness the concretes require an average of 6.07 gal of water per sack, while the plastic mortar requirement averages 5.50 gal. The high fineness type III cements require a very slight increase in mixing water for concrete (0.66 per cent), yet their plastic mortars need less water by a full 2.00 per cent, due to increased plasticity imparted by the high cement fineness.

This discrimination between types of cement by plastic mortar test specimens, depending on fineness, is not an indictment of the plastic mortar test, but rather a valuable advantage, since it provides a closer relationship between mortar tests made in the laboratory and prediction of concrete strengths in the field. If strength relations between plastic mortar tests and concrete with the type III cements had been plotted separately from those of type I and II cements, a considerably better concordance would be noted than for briquet-concrete strength relations.

Figure 5 showing relations between

TABLE I.—COMPARATIVE WATER-CEMENT RATIOS FOR BRIQUET MORTARS, PLASTIC MORTARS, AND CONCRETE.

(Data in Terms of U. S. gal per Sack)

Plant	Type	Briquet Mortar	Plastic Mortar	Concrete	Plant	Type	Briquet Mortar	Plastic Mortar	Concrete
	Types I and II Cement					Types IA and IIA Cement			
A	II	4.74	5.31	6.06	A	IIA	4.69	4.96	5.54
D	I	4.74	5.64	6.04	G	IIA	4.74	5.17	5.51
D	II	4.74	5.30	6.01	H	IA	4.74	5.19	5.63
B	I	4.83	5.64	6.31	Average		4.72	5.11	5.56
E	II	4.74	5.53	6.05		Type III			
I	I	4.74	5.53	6.18	D	III	4.87	5.41	6.17
G	II	4.74	5.53	6.05	F	III	4.92	5.41	5.99
H	I	4.92	5.87	6.29	M	III	4.92	5.08	6.04
C	I	4.83	5.53	5.98	D	III	4.92	5.48	6.11
F	I	4.74	5.31	5.89	K	III	4.92	5.53	6.27
I	II	4.74	5.31	6.03	L	III	4.92	5.53	6.23
H	II	4.88	5.53	5.98	B	III	4.97	5.42	6.22
					A	III	4.97	5.36	6.01
					N	III	4.85	5.31	6.00
Average		4.78	5.50	6.07	Average		4.92	5.39	6.11

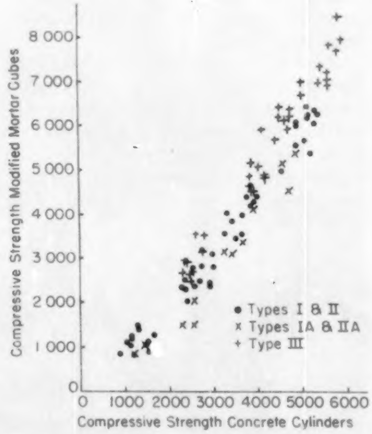

Fig. 6.—Compressive strength, concrete cylinders *versus* modified mortar cubes.

strength of 2-in. cubes and concrete strengths also shows this discrimination between types of cement, with strengths of air-entrained concrete being under estimated and type III cement concrete strengths overestimated as compared with data for types I and II.

Figure 6 giving relations between 40-mm modified cubes and concrete shows an almost identical pattern, with air-entrained concretes below the average line and with the type III cement concretes all above it.

In our estimation the 40-mm prisms for determinaton of the flexural and compressive strengths of cement mortars as now described in ASTM Methods C 348[3] and C 349[4] should soon supplant both the briquet and 2-in. plastic mortar cube. The relation between tension and compression is obtained on a single specimen made with a realistic water-cement ratio. Costs of the transition are relatively small. Prism molds are only a fraction of the cost of cube molds in price. No new testing machinery is required. The present briquet machine can be adapted for flexure tests merely by changing clips. A simple device for modified cube tests is all that is needed for the compression testing. Laboratory groups interested in more than routine acceptance tests of cement are urged to equip themselves with prism molds and adapters for testing them. The Working Committee on Strength will welcome any correlations between strengths of briquets, cubes, and flexural and compression tests on prisms that are developed.

In the meantime, it is suggested that the Sponsoring Committee on Portland Cement consider supplanting the briquet test with the compressive strength test in Table II of ASTM Specification C 150,[5] when the type of strength test is not specified by the purchaser. I have previously pointed out some faults of the briquet shape which need no repetition here. Added to this is the unrealistically low water-cement ratio in the briquet mortar, and the lack of discrimination between types of cement. We should by all means adopt as soon as possible a single standard specimen that will yield more concordant results.

[3] Tentative Method of Test for Flexural Strength of Hydraulic Cement Mortars (C 348 - 57 T) 1958 Book of ASTM Standards, Part 3.

[4] Tentative Method of Test for Compressive Strength of Hydraulic Cement Mortars (Using Portions of Prisms Broken in Flexure) (C 349 - 58 T), 1958 Book of ASTM Standards, Part 3.

[5] Specification for Portland Cement (C 150 - 56), 1956 Supplement to Book of ASTM Standards, Part 3, p. 1.

A Disk Shear Test for Adhesives

By S. B. TWISS and L. B. CLOUGHERTY

An apparatus is described for measuring the shear strength of adhesives in metal to metal bonding which minimizes peeling stresses and permits measurements at elevated temperatures. The effect on bond strength of etching of steel adherends is explored.

THE INCREASING use of adhesives in structural applications has focused considerable interest on methods of determining strength properties of adhesives in metal-to-metal bonding. One of the most important of these properties is shear strength. There are two ASTM methods for measuring adhesive shear strength: a lap shear test, Tentative Method D 1002 - 53 T, "Strength Properties of Adhesives in Shear by Tension Loading (Metal-to-Metal),"[1] and a block shear test, Method D 905 - 49, "Strength Properties of Adhesives in Shear by Compression Loading."[2]

The widely used lap shear test has much to recommend it. Among its advantages are precision, simplicity, and widespread use. It is not, however, an accurate measure of adhesive shear strength. The direction in which the separating force is applied causes a combination of shear and peeling stresses, due to eccentricity of loading, so that the strength measured is not the actual adhesive shear strength. This eccentricity of loading is increased as the shear strength increases. A description of this effect is clearly outlined by De Bruyne and Houwink.[3]

The block shear test, ASTM Method D 905 - 49, is specific for wood adhesives.

SUMNER B. TWISS is Assistant Chief Engineer of Chrysler Engineering's Basic Sciences Section. He holds a B.S. degree from Trinity College and a Ph.D. degree in chemistry from the Johns Hopkins University. He has edited a book on high polymers and published 25 papers in the fields of adhesion energy, corrosion, lubrication, weathering of paints, and infrared spectroscopy.

LEO B. CLOUGHERTY has a B.S. and M.S. degree in chemistry from Duquesne University and has carried out advanced studies in organic chemistry at Purdue University. He is supervisor of organic research in the Chemical Research Department of Chrysler's Basic Sciences Section. For the past five years, he has been engaged in research on adhesives and coatings.

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[1] 1955 Book of ASTM Standards, Part 6, p. 1040; Part 7, p. 1207.

[2] 1955 Book of ASTM Standards, Part 7, p. 1203.

[3] N. A. DeBruyne and R. Houwink, "Adhesion and Adhesives," Elsevier Publishing Co., Houston 25, Texas. pp. 96-97 (1951).

Fig. 1.—Disk shear fixture, assembled.

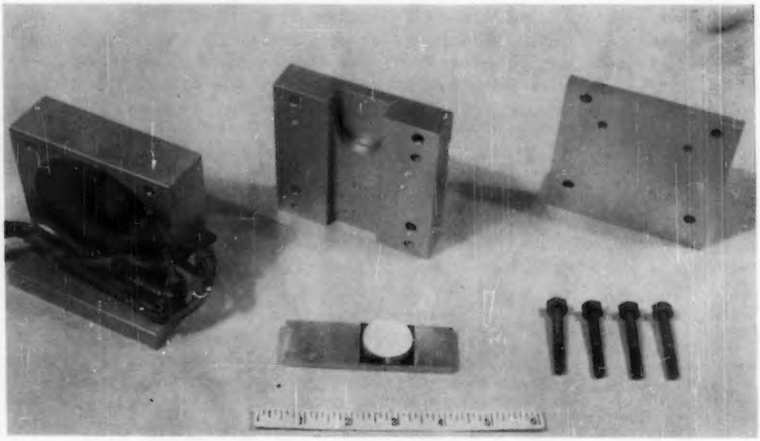

Fig. 2.—Disk shear fixture, disassembled.

In this test, two overlap bonded blocks are sheared by compression loading. The ram used for loading has a universal swivel to compensate for misalignment of the specimen. A modification of this test in our laboratory, using metal specimens, resulted in low apparent shear strength and a very low order of reproducibility. This was attributed to misalignment of the specimens.

In order to obtain a more accurate measure of adhesive shear strength conveniently, a new test method was designed. This test consists of shearing a disk from a rectangular strip by compression loading. The specimen can rotate slightly in the test fixture and, therefore, is self-aligning. Peeling stresses are minimized by maintaining a very small clearance between the specimen and the shearing tool. This arrangement does not cause the specimen to bind in the fixture. The use of thick sections for the adherends also reduces peel forces. In addition, the circular shape of the bonded area may achieve a more uniform distribution of stresses than is obtainable in the lap shear test.

Test Apparatus

Photographs of the disk shear test fixture, assembled and disassembled, are shown in Figs. 1 and 2. The semicircular anvil was made of hardened steel to prevent deformation during loading. The anvil was bolted to the spacer for increased rigidity. One of the aluminum frames was machined to contain a heater and a thermostat. The heater selected was a Chromalox disk element, 115 v–400 w, type HSP-31.

The thermostat used was a Fenwal Thermoswitch, 5 amp, 115 v ac, 0 to 600 F range, Catalog No. 17002-0.

A pilot light was inserted in the heater circuit. No insulation was required, since the temperature variation proved to be only ± 2 F at a thermostat setting of 400 F.

The specimens consisted of disks and strips of the desired metals. The strips were rectangular pieces 1.125 by 4.250 by 0.250 in. thick. The disks were 1.125 in. in diameter and 0.250 in. thick. A hole 0.09 in. in diameter was drilled from the edge of the disk to the center for insertion of a thermocouple to determine specimen temperature for elevated temperature testing.

In order to evaluate the disk shear test, it was decided to compare it directly with the lap shear test (ASTM Method D 1002 – 53 T).[1] This comparison was designed to include average strengths obtained and precision of the two tests, both at room temperature and at elevated temperatures. Groups of 20 to 50 specimens were tested so that a statistical analysis of lap shear *versus* disk shear results could be made. In addition, studies of the effect of loading rate in the disk shear test and the effect of etching of steel on the shear strength of H2S cement were included.

A series of specimens was planned to include two metal adherends, aluminum and steel, with two different adhesives. AA 2017 aluminum was used for the disk shear specimens and Alclad AA 2024-T3 panels (6.375 by 3 by 0.064 in.) were used for lap shear specimens. Cold-rolled, plain carbon steel (SAE 1010) was used for both disk and lap shear specimens. Two adhesives were selected: Cycleweld C-14 and Cycleweld H2S. The former is a modified epoxy type liquid adhesive that can be cured at ambient temperatures and contact pressure. It has the high shear strength and low peel strength typical of epoxy adhesives. Cycleweld H2S adhesive is a rubber-resin type adhesive of spray viscosity, requiring considerable heat and pressure to effect a cure. It has a solids content of 26 ± 2 per cent and a viscosity of 3500 ± 200 cps at 80 F. The viscosity increases slowly on aging. The H2S cement was checked against these specifications before use. This adhesive has relatively lower shear strength and higher peel strength than the epoxy type.

Experimental

Metal Preparation

The disk shear adherends, both aluminum and steel, were surface ground to 0.250 in., sanded with 180-grit aluminum oxide cloth, and cleaned with hot trichloroethylene. This completed the surface preparation of the steel pieces for C-14 bonding and for H2S bonding without etching. To obtain optimum strengths with H2S adhesive, the steel pieces were etched with a 10 per cent sulfuric acid solution at 122 F. After a 5-min immersion, the surfaces were washed with distilled water and wiped dry. The aluminum disks and strips were given a chromic acid etch as a final surface preparation. The etching bath used was a solution containing the following in parts by weight: potassium dichromate 11.1, sulfuric acid 100, and water 340.[4]

The aluminum was held in the bath 10 min at 155 to 160 F. A water rinse and thorough drying completed the surface preparation.

The steel panels for lap shear specimens were sanded with 180-grit aluminum oxide cloth and cleaned with hot trichloroethylene. Panels for H2S specimens only were then etched the same as the H2S disk shear specimens. The aluminum panels were cleaned with hot trichloroethylene and etched with chromic acid solution, in a similar fashion to the disk shear specimens.

[4] H. W. Eickner and W. E. Schowalter, "A Study of Methods for Preparing Clad 24S-T3 Aluminum-Alloy Sheet Surfaces for Adhesive Bonding," *Reports Nos. 1813 and 1813A*, Forest Products Laboratory.

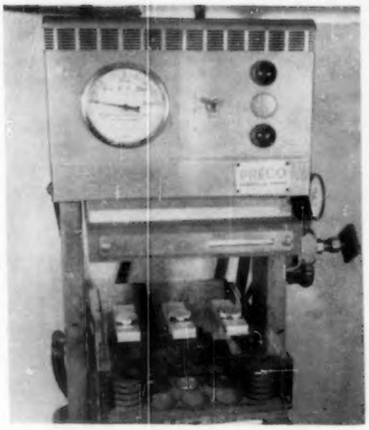

Fig. 3.—Bonding jig in heater press.

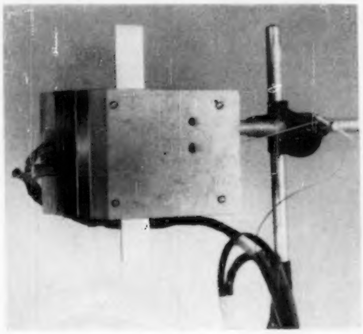

Fig. 4.—Lap shear heater, closed.

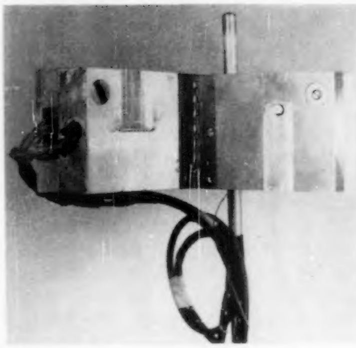

Fig. 5.—Lap shear heater, open.

Bonding Procedures

In preparing the C-14 adhesive disk shear specimens, the C-14-A (resin) and C-14-B (hardener) were mixed according to the manufacturer's directions and applied to the disk and the center portion of the strip. When the adhesive became quite tacky, the disks were centered on the strips. Masking tape shims were used to maintain the desired glue line thickness. A light weight was applied to keep the adherends in place. The adhesive curing cycle was 16 hr at ambient temperature, followed by 40 min at 185 F. After cooling, the specimens were ready for testing, as shown in Fig. 2.

The C-14 adhesive lap-shear specimens were prepared in a similar manner, using 6-in. wide panels and 0.500 in. overlap. After curing, all panels were sawed into strips 1 in. wide for testing.

For the H2S adhesive disk-shear specimens, the cement was applied to both the disks and the center sections of the strips and leveled with a spatula. Shims of masking tape were used to produce wet film thicknesses of 0.020 or 0.013 in., depending on the final bond thickness desired. The adhesive was air dried for 1 hr and precured 25 min at 180 F. The disks were then centered on the strips and cured for 30 min at 200 psi and 365 F. A Preco hydraulic laboratory press supplied the heat and pressure for bonding. The press platens were electrically heated. A spring-loaded bonding jig was used to control the bonding pressure, as shown in Fig. 3.

The jig consisted of two steel plates (7 by 8 in.) separated by calibrated springs. Accurately machined side spacers retained the upper plate and allowed it to move as the press was closed. By selection of springs with the proper rate, any desired loading could be obtained. The jig was heated by the press platens; specimens to be bonded were inserted between the upper press platen and the upper plate of the bonding jig. Normally, three disk-shear specimens were lined up across the center of the upper plate, the press closed immediately, and the specimens maintained under a uniform pressure of 200 psi for 30 min.

H2S adhesive lap-shear specimens were bonded with a 0.500-in. overlap using the same bonding arrangement, pressure, and temperature as for the disk-shear specimens.

Testing Procedure

A Tinius Olsen Lo-Cap universal testing machine was used for all shear strength tests. A loading rate of 0.05 in. per min was used throughout the testing, except in cases where loading rate was being studied. Disk-shear specimens were loaded in compression, using the disk-shear fixture. For elevated temperature tests, the fixture was heated to the desired temperature and the specimen placed in the fixture. After 10 min in the heated fixture, the load was applied. A thermocouple inserted in the disk recorded the temperature. Specimens reached test temperature in about 2 to 3 min.

Lap-shear specimens were tested in tension, using standard Templin jaws. For elevated temperature tests, a compact, insulated, thermostatically controlled heater was used.

Figures 4 and 5 illustrate two views of the lap-shear test heater. Two aluminum blocks hinged together formed the body of the fixture. One block had a Thermoswitch inserted in a hole drilled into the center of the block, and a Chromalox heater bolted to its outer face. Slots were cut in the inner face of each aluminum block to accommodate the test specimen and hold it in contact with the heated block. A spring-loaded aluminum button containing a thermocouple was mounted at the back of the slot in the unheated block and opposite the specimen overlap. This arrangement gave positive contact between the thermocouple and specimen when the heater was closed. The back faces of both aluminum blocks were covered with Transite to provide insulation for improved temperature control. The heater was held closed by a magnetized iron button embedded in the inner face of one block and facing an iron button embedded in the other block. A rod threaded into the heated block permitted the heater to be mounted on a ring stand, which could be set on the base of the universal testing machine. Silicone grease was smeared on the test strip to give good contact with the heated aluminum block and thermocouple carrier. The specimen was inserted, the heater closed and the two ends of the specimen clamped in the Templin jaws. The preheated fixture brought the lap shear specimen to temperature within 2 min. Temperature variation was ±2 F. Specimens were kept in the heater 10 min prior to testing at the elevated temperatures.

TABLE I.—COMPARISON OF DISK-SHEAR AND LAP-SHEAR TEST RESULTS AT ROOM TEMPERATURE.

Adhesive	Adherend	Lap-Shear Tests			Disk-Shear Tests		
		Shear Strength, psi	Standard Deviation, σ, psi	Number of Specimens	Shear Strength, psi	Standard Deviation, σ, psi	Number of Specimens
C-14...	Aluminum	3371	384[a]	51	5848	442[a]	48
C-14...	Steel	2824	159	24	5182	429[a]	50
H2S....	Aluminum	2236	188	24	3360	187	20
H2S....	Steel[b]	2466	166	24	3232	238	20

[a] Results obtained June, 1956. All other tests were made June, 1957.
[b] Steel etched with dilute sulfuric acid.

Results and Discussion

The series of tests comparing bond strengths included aluminum-to-aluminum and steel-to-steel disk-shear specimens bonded with each adhesive. The same four combinations of adhesives and adherends were tested in the lap shear test. It should be noted that, in the case of the steel specimens bonded with C-14 adhesive, the steel was not etched. However, for steel specimens bonded with H2S adhesive, optimum results were obtained with steel etched with dilute sulfuric acid. The average shear strengths at room temperature, standard deviation, and number of specimens tested are listed in Table I. It is evident from this table that the disk-shear test gives substantially higher values than the lap shear test. The disk shear results using C-14 adhesive are 73 per cent higher on aluminum and 83 per cent higher on steel than the comparable lap-shear test. This is precisely the effect to be expected if peeling stresses were effectively reduced. In the case of the H2S adhesive, which has good peel strength and lower shear strength, the difference of 44 per cent for aluminum and 31 per cent for steel are less marked. The C-14 bonded joints characteristically failed in adhesion to metal, whereas the H2S bonds failed predominately in cohesion in the adhesive.

The only way of determining the precision of a test method is to make a statistical analysis of a large number of test results. Such an analysis was made for each of the specimen groups tested in this work. The precision of the disk and lap shear test appears to be about the same. The standard deviation σ was calculated for each group of specimens. They vary between 159 psi and 442 psi, as shown in Table I. However, the three standard deviations marked with asterisks were tested at an early phase of the program and ranged from 384 to 442 psi. The five other groups were prepared 12 months later and ranged from 159 to 238 psi. This is definite indication that the precision of the two tests is equally good and that precision depends primarily on the care exercised during the preparation of the test specimens. Probability curves for C-14 adhesive on both steel and aluminum are shown in Fig. 6. It should be noted in Fig. 6 that the precision of the C-14 adhesive results on the steel by the lap-shear test is of a different order of magnitude than the results on aluminum and steel by the disk-shear test. This is due to the fact that the results with a higher order of precision were obtained at a later date than the earlier results and represent improved techniques of the operator in preparing and testing specimens. It can be easily seen from this curve that both lap shear and disk shear have comparable precision and the disk-shear strengths on both aluminum and steel are significantly higher than those of the lap shear test. Similar probability curves are given in Fig. 7 for H2S adhesive. Here again, it is observed that a comparable order of precision is obtained for the lap- and disk-shear tests and that strengths for both etched aluminum and etched steel are higher by the disk-shear test than by the conventional lap shear.

Tests made at elevated temperatures give further evidence that peeling stresses due to eccentricity of loading in lap-shear tests reduce the observed shear strength. The results of a comparison of the lap- and disk-shear tests at elevated temperatures are given in Table II. Only H2S adhesive was used in

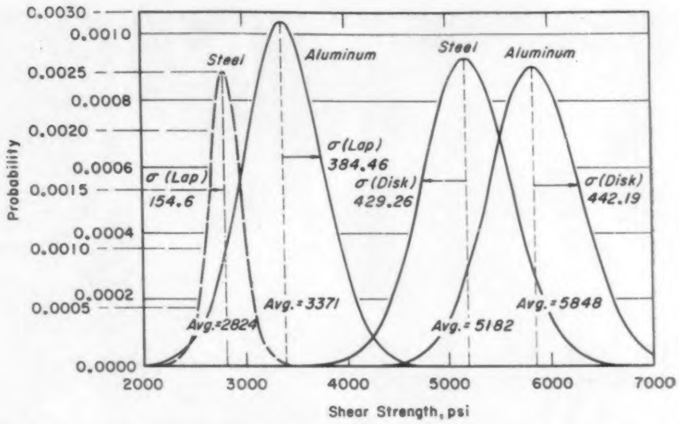

Fig. 6.—Probability curves of disk and lap shear strengths, C-14 adhesive.

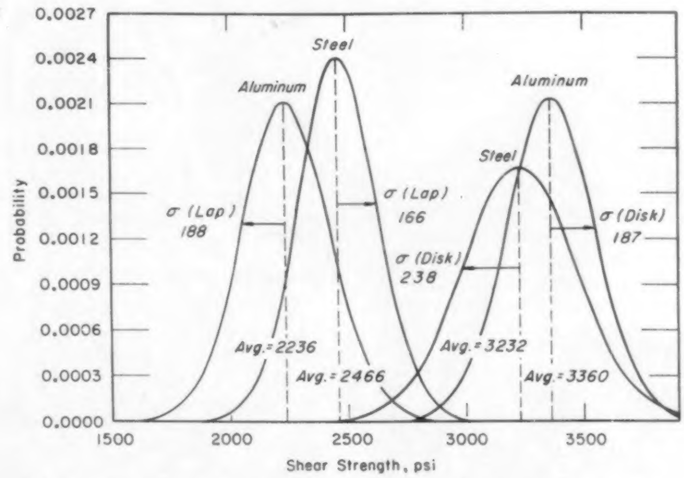

Fig. 7.—Probability curves of disk and lap shear strengths, H2S Adhesive.

TABLE II.—COMPARISON OF SHEAR STRENGTHS OF H2S ADHESIVES AT VARIOUS TEMPERATURES.

Test Temperature	Adherend[a]	Lap-Shear Tests			Disk-Shear Tests		
		Shear Strength, psi	Standard Deviation, σ, psi	Number of Specimens	Shear Strength, psi	Standard Deviation, σ, psi	Number of Specimens
Room temperature....	Aluminum	2236	188	24	3360	187	20
Room temperature....	Steel	2466	166	24	3232	238	20
300 F..............	Aluminum	1010	178	10	1544	103	10
400 F..............	Aluminum	511	98	10	1007	74	10
400 F..............	Steel	1050	71	12	943	67	9
500 F..............	Steel	500	90	12	370	35	9

[a] All metal specimens etched before bonding.

this study, since the C-14 epoxy adhesive is not suitable for the temperature range chosen. It can be seen that, as the testing temperature was increased, the differences in the two tests disappear. As the adhesive became progressively softer, shear strengths became very low and the lap-shear specimens were not loaded sufficiently to give significant distortion of the adherends. For this reason, no substantial peel forces were encountered at the highest test temperatures, and the lap shear and disk shear results are comparable. It is significant, however, that the lap-shear strength of H2S adhesive on steel at 500 F is comparable to the strength of aluminum specimens at 400 F.

Since extensive data on the effect of etching of steel on shear strength at elevated temperatures has not been published, it was believed of interest to compare the effect of etching, based on our small amount of data. These results for H2S adhesive are given in Table III. The effect of etching is relatively minor at room temperatures, ranging from 15 per cent for the lap-shear test to 31 per cent for the disk-shear test. The effect of etching is surprisingly great at the elevated temperatures of 400 and 500 F, ranging from 100 to 155 per cent. It is generally recognized that, with this type of rubber-resin cement, the limiting factor for shear strength at elevated temperature is softening of the cement and loss of cohesive strength. These results would

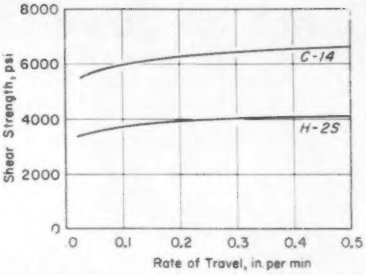

Fig. 8.—Effect of loading rate on disk shear strength, aluminum adherends.

seem to indicate that the adhesive component of shear strength is also important and is markedly affected by the method of surface preparation.

It has been shown that, at least for low-modulus type adhesives, an increase in loading rate in lap-shear testing increases the apparent shear strength of a bond.[5] This effect appears to be present for the disk-shear test for both a low and high modulus adhesive, as demonstrated in Fig. 8. A limited range of loading rates was used: five crosshead travel rates, ranging from 0.025 in. per min to 0.5 in. per min. Five specimens were tested at each rate. Both adhesives were tested using aluminum adherends. In spite of the limited range of crosshead travel, both adhesives required increasing stresses for breaking as the loading rate increased.

Conclusions

1. Based on this preliminary evaluation, the disk-shear test would appear to be a precise method of determining adhesive shear strength. The precision of the test is comparable to that of the lap-shear test as determined by the standard deviation of a statistically adequate number of specimens.

2. The disk-shear test gives significantly higher observed shear strengths than the commonly used lap-shear test for both low modulus and high modulus adhesives and for two adherends—aluminum and steel. This is considered as evidence that peel forces have been substantially reduced in the disk shear test.

3. The preparation of disk-shear specimens is not especially complicated and requires no more time than the preparation of lap shear specimens, provided that several specimens are bonded simultaneously.

4. As compared with the block-shear test, the circular shape of the disk-shear specimen gives the highly desirable feature of self-alignment when loaded in compression. It is probable that the disk has less concentration of stresses at the edge of the bond, although this effect has not been demonstrated directly.

5. The effect of etching of steel adherends, in the case of bonding with H2S adhesive, has been shown to have a significant effect on the bond strength at room temperature and a marked effect on the bond strengths at elevated temperatures. This applies to both lap- and disk-shear testing.

6. An effect of loading rate within a limited range appears to exist in the disk-shear test for both low modulus and high modulus adhesives. Increasing rate of crosshead travel increases the observed shear strength.

7. Further evaluation of the shear test is necessary before its scope and usefulness are established.

Acknowledgment:

Acknowledgment is made of the work of John Kermedjian, who designed and developed the heating fixture for elevated temperature testing of lap-shear specimens.

[5] R. E. Wittman, *Technical Report 54-153*, Wright Air Development Center, Dec., 1954.

TABLE III.—EFFECT OF ETCHING[a] OF STEEL ON SHEAR STRENGTH, H2S ADHESIVE.

Shear Test	Temperature	Without Etching: Shear Strength, psi	Without Etching: Standard Deviation, σ, psi	Without Etching: Number of Specimens	With Etching: Shear Strength, psi	With Etching: Standard Deviation, σ, psi	With Etching: Number of Specimens	Per Cent Increase
Lap..	Room temperature	2145	211	24	2466	166	24	15
	400 F	515	102	10	1050	71	12	104
	500 F	196	64	10	500	90	12	155
Disk..	Room temperature	2468	151	24	3232	238	20	31
	400 F	428	67	10	943	67	9	120
	500 F	184	70	10	370	35	9	101

[a] 5 min immersion in 10 per cent sulfuric acid at 122 F.

Technical Notes

As TESTING techniques and minor modifications of testing procedures or equipment and new approaches to the many other facets of materials testing are often of considerable current interest, the editors are providing space for brief technical notes. This will serve as a forum for the exchange of information in the materials testing field for brief items which do not warrant treatment in a more extensive technical paper. The first such item appears in this issue on page 67.

Contributions invited.—Technical Notes should be no more than a few hundred words in length, with no more than three figures or short tables. Please address contributions to the editor, ASTM BULLETIN, American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

A Checking Device for Strain-Gage Indicators

By BLAKE D. MILLS, JR.

When a strain-gage indicator or recorder is to be used with resistance strain gages, it is highly desirable to be able to check the equipment quickly for proper operation before strain measurements are undertaken. The commercially available strain-gage indicators and recorders are usually highly reliable. Nevertheless, some of their component parts may be subject to failures which affect the accuracy of the readings unnoticed by the operator. A simple checking device, developed by the author, ensures the operator that the indicator is functioning properly.

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The checker is designed to be inexpensive, rugged, easy to fabricate, easy to use, and does not require any critical adjustments. The sensitive element of the checker is a flat cantilever beam with one resistance-wire strain gage cemented to its upper surface, one to its lower surface, and a small weight attached to its free end. The two gages are connected to the gage input terminals of any strain indicator or recorder with the usual circuit for two external gages, one in tension, the other in compression. A fixed increment of strain is produced simply by turning the checker over, so that the beam deflects in the opposite direction. Any vibration of the beam can be immediately stopped with the touch of a finger.

The beam of the checker can be supported in any convenient manner to provide at least moderate rigidity. Even slight play in a less rigid support of the beam would not measurably affect the strain increment. Figure 1 shows two forms of the checker made and used by the author, one with its beam mounted in a 2 by 2 by 6-in. wooden block, the other with a metal frame consisting of a 1-in. wide strip of aluminum. The former is shown connected to a Baldwin strain-indicator.

The wooden checker shown in Fig. 1 has an aluminum-alloy beam 0.020 in. thick, 1 in. wide, and 5 in. long with an aluminum block $\frac{1}{2}$ by $\frac{3}{8}$ by 1 in. attached to its free end. Centered 3 in. from the free end of the beam, one SR4 type A-11 strain gage is cemented to the upper surface and one to the lower surface of the beam. With the strain indicator set for a gage factor of 2.00, this arrangement produces a strain indication of 560 microinches per in. whenever the checker is turned over.

Figure 2 shows the principal dimensions of the wooden checker and an assembly sketch of the metal checker.

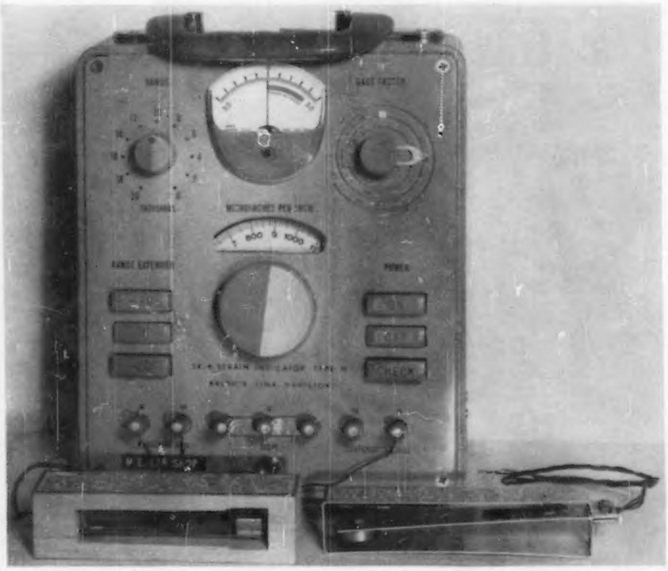

Fig. 1.—Wooden-frame checker (left) and all-metal checker, with strain indicator.

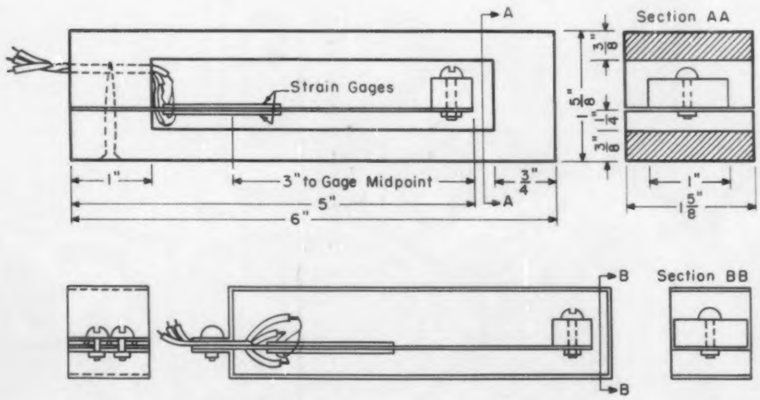

Fig. 2.—Details of strain-gage indicator checkers.

BLAKE D. MILLS, JR., is a professor of mechanical engineering at the University of Washington, where he has been teaching and conducting research in the field of engineering materials since 1946. He also serves as a consultant to industry on materials problems, and was officer-in-charge of gun development for the Navy during World War II.

For each type of the device, the frame is designed to limit the deflection of the beam so that even rough handling does not cause damage or permanent set in the beam.

The checker can be used with a strain recorder in much the same manner as with a strain indicator provided the recorder is caused to draw a line first with the beam deflected in one direction, then in the other. The checker can also be used to ensure that the recorder is freely registering dynamic strains by deflecting and suddenly releasing the beam in the checker, a convenient method to produce an oscillogram. The speed of travel of the recorder paper or the speed of an oscilloscope sweep circuit can also be checked if the natural frequency of the checker is first established from an oscillogram made with a known speed of the recorder paper.

Calibrating units for checking strain-gage indicators, using stepped electrical resistances, are available commercially. However, the versatility and low cost of the checking device described herein may make this device of practical interest to many strain gage users, as it has been to the author.

A High Shear Rate Capillary Rheometer for Polymer Melts*

By E. H. MERZ and R. E. COLWELL

POLYMER melts are non-Newtonian and compressible. The response of a polymer melt to an applied stress is further complicated by the time dependency of the compressibility (**1**)[1] and by the recoverable elastic portion of the total compliance (**2**). Many instruments have been devised to measure the response of a polymer melt. In general, they may be classed as rotational (**3**) wherein the material is sheared in a narrow annulus, or as extrusion (**4**) wherein the material is forced through an orifice. The major limitation of the rotational viscometers is that at high shear rates, $>100\ \text{sec}^{-1}$, the polymer tends to climb out of the cylindrical gap. The major limitation of the capillary extrusion type is the inability to distinguish adequately between energy losses due to entrance and exit effects compared to the energy loss due to steady state flow.

The basis for the design of the capillary extrusion rheometer herein described was that the capillary length was to be sufficient to make the energy losses due to steady state flow large with respect to the energy losses due to transient effects (**5**). A possible additional benefit from the choice of a capillary extrusion type was that, due to the geometrical similarity with many polymer processing machines, correlations could be readily established.

The application of the results from the rheometer to problems in the processing of polymers are discussed.

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

* Presented at the Fall Meeting of ASTM Committee D-20, Virginia Beach, Va., Nov. 21, 1957.

[1] The boldface numbers in parentheses refer to the list of references appended to this paper.

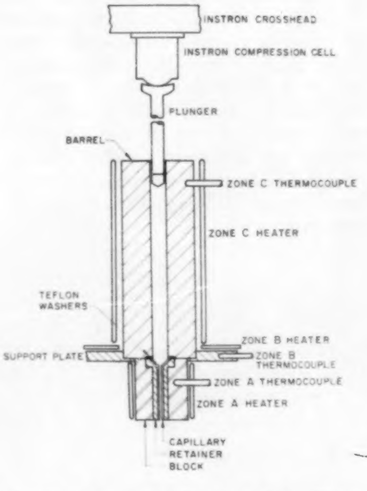

Fig. 1.—Schematic diagram of the Monsanto capillary extrusion rheometer.

Experimental

The essentials of the rheometer are shown in the schematic diagram, Fig. 1. A 5000-lb capacity Instron testing machine drives the plunger through the barrel at rates from 0.02 to 20 in. per min and records the force required on a chart moving in synchronization with the plunger. The Instron machine is fitted with a set of magnetic clutches permitting rapid rotary switch selection of speed. The barrel bore is 0.375 in. in diameter and 14.25 in. long. The diameter of the barrel was chosen so that with the barrel at 400 F, polystyrene at 70 F could be added and the centerline temperature would rise to within 1 F of the set temperature within 3 min.

Capillary tubes ranging from 0.0625 to 0.032 in. inside diameter and up to 6 in. long were available—length-to-diameter ratios of 3.5 to 188.

EDMUND H. MERZ was graduated at the University of Michigan in 1944 with the degree of B.Sc. in Chemical Engineering. In 1945 he was awarded the M.S. degree by the Polytechnic Institute of Brooklyn, and two years later received the Ph.D. from that institution. In 1947 he joined the Plastics Division of the Monsanto Chemical Co., where he is presently Group Leader of the Applied Physical Chemistry Research Group. He is the author of twelve publications on polymers and has been issued two patents.

ROBERT E. COLWELL, a scientist in the Engineering Section, Plastics Division Research Department, Monsanto Chemical Co., was graduated from the University of Rhode Island in 1943. He has been concerned with problems in polymer processing technology, drying, engineering, rheology, and intensive mixing. He is a member of the A.I.Ch.E., A.C.S., Soc. Plastics Engineers, and the Society of Rheology.

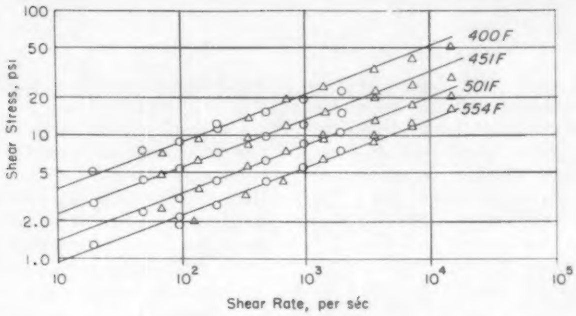

Fig. 2.—Flow curve for a commercial polystyrene. Circles refer to a 0.0625 by 4-in. capillary. Triangles refer to a 0.0320 by 4-in. capillary.

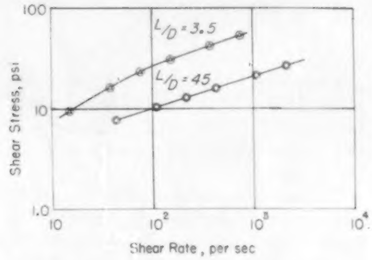

Fig. 5.—Flow curves of polyethylene.

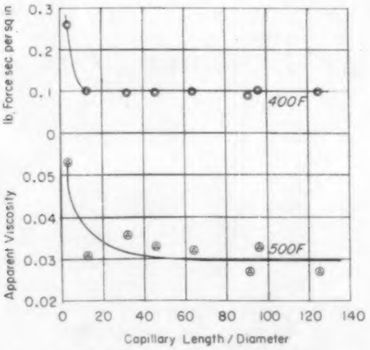

Fig. 3.—Effect of capillary L/D ratio upon the viscosity of polystyrene.

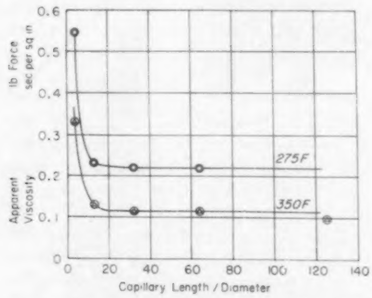

Fig. 4.—Effect of capillary L/D ratio upon the viscosity of polyethylene.

One winding of each of the double-wound 220 v heaters was connected to a variable voltage controller; the other winding was connected to a saturable reactor controller. Voltmeters were connected in these latter lines. Control thermocouples were placed, by trial and error, so that the centerline temperature throughout the barrel and capillary (neglecting end effects) could be controlled to within 0.5 F both as a function of position and of time. Temperatures were surveyed by inserting a 30 gage iron-constantan thermocouple along the centerline of both barrel and capillary.

The procedure followed during a run was:

1. With the rheometer at test temperature and the electronic circuits of the Instron calibrated, and balanced, about 20 g of polymer were packed into the barrel incrementally to minimize air entrapment.

2. After 5 min from the start of filling and with the voltmeters in the controlled heating circuits indicating a steady voltage, the plunger was run through the barrel at a preselected rate.

3. After the force trace remained at a fixed level indicating steady state flow, another (usually larger) plunger speed was selected without stopping the plunger motion, and so forth. It was possible to repeat this procedure as many as seven times with one filling.

4. The force *versus* speed data were used to calculate a shearing stress at the wall,

$$S = \frac{\Delta P r}{2L} \qquad (1)$$

where:

ΔP = pressure drop through the capillary, psi.
r = radius of capillary, in., and
L = length of capillary, in.

and an average shear rate

$$D = \frac{4Q}{\pi r^3} \qquad (2)$$

where Q = volumetric rate of flow in cu in. per sec.

The logarithm of the shear stress was plotted *versus* the logarithm of the shear rate. The reciprocal slope of the line, n, was used to calculate the shear dependence parameter, m, by

$$m = \frac{(n-1)}{n} \qquad (3)$$

5. Results were summarized by an empirical equation of the form

$$\mu = \mu_s \frac{(D)^{-m}}{(D_s)} e^{-b(t-t_s)} \qquad (4)$$

where:

μ = apparent viscosity defined as S/D, lb force sec per sq in.,
b = temperature coefficient, F^{-1},
t = temperature, deg Fahr, and
subscript s = standard reference state.

usually

D_s = 100 sec^{-1} and
t_s = 400 F.

The results for a commercially pure polystyrene are given in Fig. 2 and can be approximated to within ±5 per cent by the equation

$$\mu = 0.090 \frac{(D)^{-0.61}}{(100)} e^{-0.0089(t-400)} \qquad (5)$$

This empirical equation was developed to provide an easy means for extrapolating viscosity data for engineering purposes. It has the virtue of yielding the apparent viscosity, that is, the resistance to deformation of the material at a given shear rate. Deviations from linearity of the log S *versus* log D plot (which must occur at low D) limit the applicable range of this correlation expression.

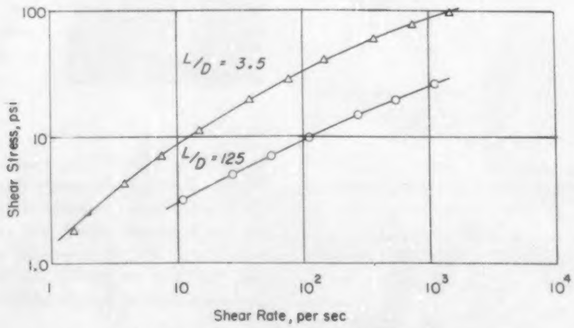

Fig. 6.—Flow curves of polystyrene.

Figure 2 also shows that, within experimental error, changing the capillary diameter by a factor of two, at constant capillary length, which enters the calculations to the fourth power did not alter the observed relationship between shearing stress and shearing rate. This point is further exemplified by the data given in Figs. 3 and 4 where the apparent viscosity is plotted against length-to-diameter ratio, L/D, of the capillaries. Figures 5 and 6 illustrate the curvature of the log S *versus* log D curve introduced by using a capillary having a small L/D.

A study of the reproducibility of results obtainable with this new instrument has shown that, with different operators on different days, the apparent viscosity can be measured to within ± 5 per cent precision over the range of shear rates from 1.5 to 11,300 reciprocal seconds.

Discussion

Equipment

The results given in Fig. 2 show that the basic design premise of the rheometer was fulfilled, namely that changing the diameter of the capillary (and the L-D ratio) by a factor of two did not change the measured apparent viscosity, shear dependence, or temperature coefficient for a commercially pure polystyrene melt. This results also argues that slippage of the melt against the wall of the capillary was negligible (**6**).

The results given in Figs. 3 and 4 show for polystyrene that satisfactory capillary extrusion rheometers must be equipped with capillaries having an L/D of about 60 in order that capillary geometry will not affect the material property, viscosity; for polyethylene, this ratio can be as low as 30. For example, an ASTM test[2] requires the use of the Melt Indexer to evaluate the single point viscosity of a material. The Melt Indexer is normally used with a capillary having an L/D of 3.8. By referring to Figs. 3 and 6, it can be seen that although a melt viscosity is obtained with this instrument, it is not a viscosity that can be regarded as a material property.

Use of Results

In attempting to solve a rheological problem, particularly where the working material is polymeric, one must be able to specify the pertinent rheological parameter, that is, whether differences in shear dependence, temperature dependence, or absolute level of viscosity controls the response of the operation.

For polymeric materials with delayed

[2] Tentative Method of Test for Measuring Flow Rates of Thermoplastics by Extrusion Plastometer (D 1238 – 57 T) 1957 Supplement to Book of ASTM Standards, Part 6, p. 52.

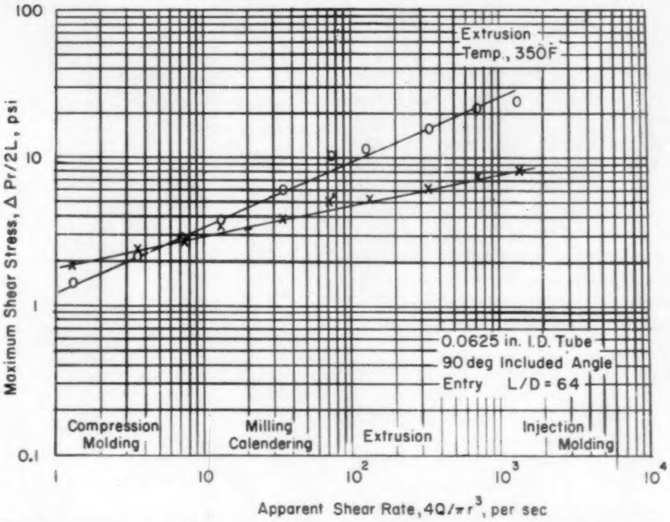

Fig. 7.—Flow curves for plasticized poly(vinyl chloride). Formulated with two kinds of plasticizer

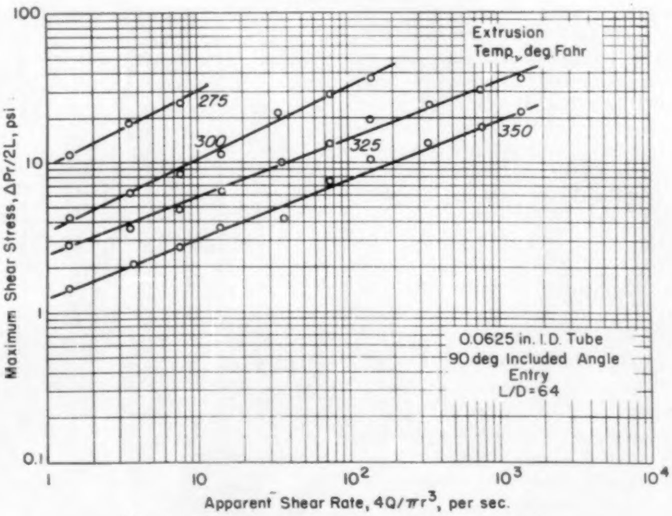

Fig. 8.—Flow curves for polystyrene-Lustrex LSA.

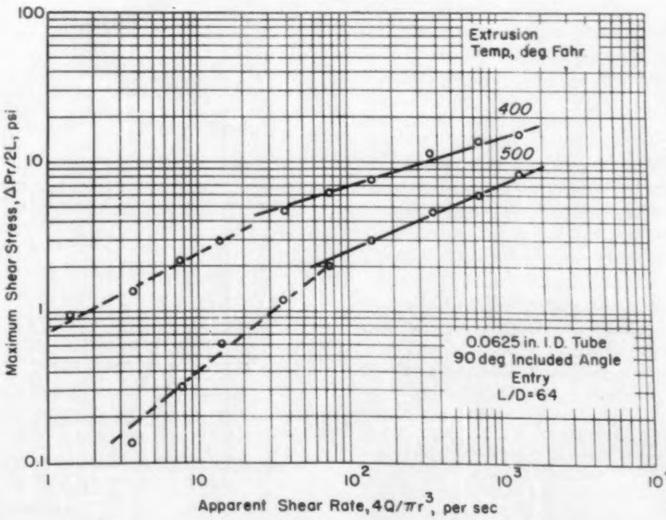

Fig. 9.—Flow curves for polystyrene-Lustrex Hi-Flow 55.

elastic effects, an important parameter when comparing the behavior of a given specimen in two different operations is the ratio of energy losses due to transient effects to the energy losses incurred in steady state deformation. It is not uncommon, for example, for two extrusion viscometers of the single point type used for control purposes to rate a series of materials in different orders. This can usually be traced back to different energy loss ratios in the two instruments (5).

The necessity for using a rheometer that can measure the response of a material over a wide range of shear rates can be illustrated as in Fig. 7. Here it can be seen that if one measures the viscosity of a plastic at about 5 reciprocal seconds, the conclusions drawn regarding the relative viscosity during a high shear rate process such as extrusion would be erroneous.

Figures 8 to 13 illustrate the rheological properties of a series of polystyrenes designed to exhibit a wide range of processability as well as of physical properties. Data are approximated by two straight lines showing the fit of the power law equations (3); arrows on the curves show the inception of "melt fracture" (8). It can be seen that, at a given rate of shear, the temperature at which these materials exhibit the same apparent viscosity varies by over 100 F. With this type of information, it becomes possible to predict optimal processing conditions for each material.

Summary

A rheometer for polymer melts has been described which will measure the melt properties of polymers at usual processing temperatures and rates of shear. It was shown that a relatively large length-to-diameter ratio, L/D, of the rheometer capillary was required before viscosities could be measured independently of the capillary geometry.

Acknowledgment:

B. M. Wood and C. A. Brown assisted in obtaining some of the data. The authors wish to thank the Monsanto Chemical Co. for permission to publish this paper.

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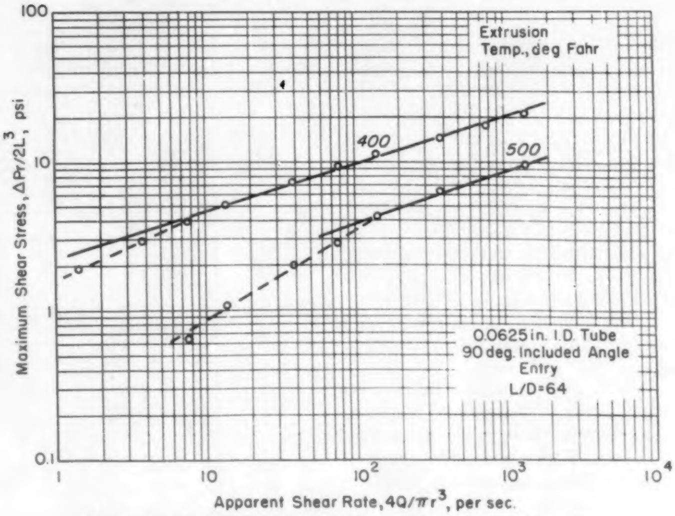

Fig. 10.—Flow curves for polystyrene-Lustrex Hi-Flow 77.

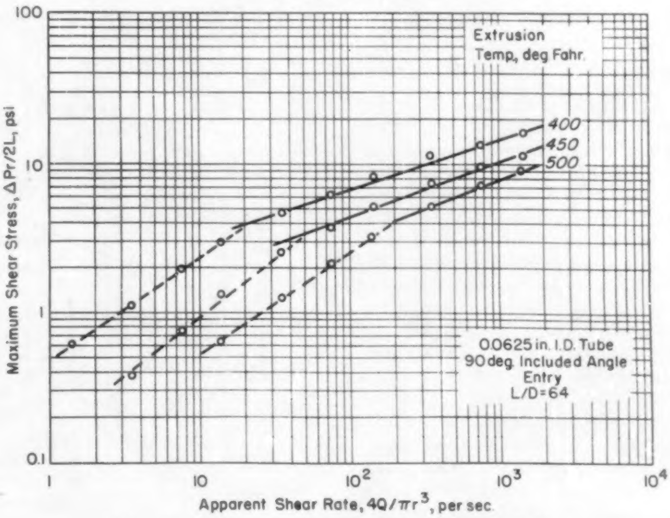

Fig. 11.—Flow curves for polystyrene-Lustrex LHA.

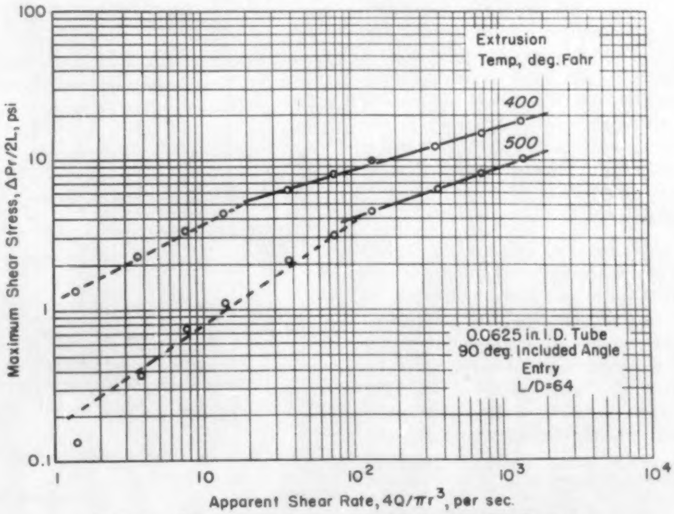

Fig. 12.—Flow curves for polystyrene-Lustrex Hi-Test 88.

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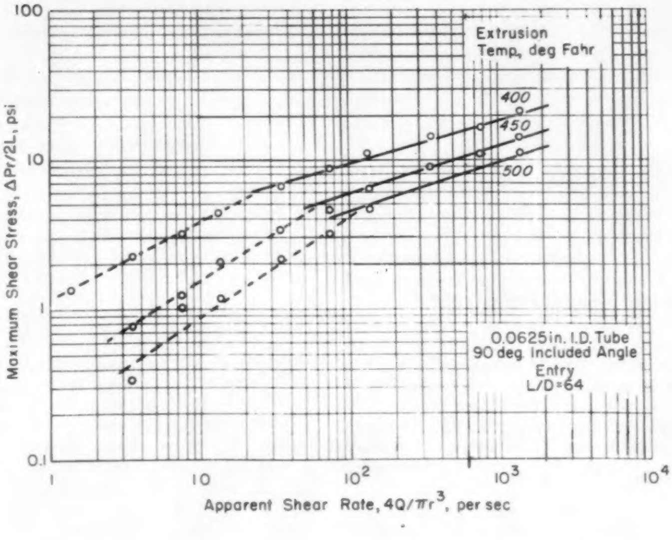

Fig. 13.—Flow curves for polystyrene-Lustrex Hi-Test 88B.

Technical Notes

New Device Tests Contraction Joint Sealer

A new test developed in the Engineering Laboratories of the Bureau of Reclamation in Denver is proving effective in evaluating performance of sealing materials used in contraction joints of concrete canal linings. The contraction joint simulator applies many of the destructive forces that act upon joint sealers in actual concrete canal linings. As a result, it now is possible to study simultaneously the effects on the sealing materials caused by aging, high and low temperatures, alternate wetting and drying, and the stresses imposed by continuous expansion and contraction of the joint.

The principal elements of the contraction joint simulator are four 2-ft rods of Plexiglas or Lucite which are painted black, to increase the heat absorption of the rods, thereby increasing the amount of expansion and contraction. Under the influence of varying ambient temperatures and solar radiation the rods simulate the daily contraction and expansion of a 10-ft-long concrete slab. As shown in Fig. 1, the rods are attached to two 6 by 12-in. concrete blocks which are separated by a third concrete block of the same dimensions. The center block is fixed while the blocks on each side are free to move with the length changes of the plastic rods. The length changes of the rods cause alternate widening and narrowing of the two contraction joints between the blocks, thereby stressing the joint sealers being tested.

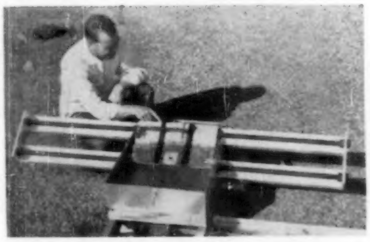

Fig. 1.—The author is shown observing the operation of a simulator. Two test sealers are in place. The concrete block in the center is fixed; those on each side are free to be moved by the length changes of the plastic rods. Also shown is the siphon for automatic water level variation.

The three blocks are partially submerged in a metal tank and are set at a slope of 1.5 to 1—approximating a typical canal side slope. The blocks are placed facing south to receive the maximum solar and weathering effect. Fresh water is continuously fed in and a siphon is set at one end of the tank opposite the blocks to control the variation of the water level automatically.

During the summer months, the upper third of the blocks is above the water surface at all times, the middle third is alternately submerged in water and exposed to air, and the lowest third is continuously submerged. During the winter months, the water is drained and the entire joint is exposed to the atmosphere. Thus, both hot and cold weather conditions, similar to those found at most canals on Bureau of Reclamation projects, are simulated for testing purposes.

The width of the contraction joints between the blocks is set initially at $\frac{5}{16}$ in. and may open to $\frac{3}{8}$ in. or close to $\frac{1}{4}$ in., to correspond to the maximum length change of a 10-ft-long concrete slab. The amount of opening and closing of actual joints for a given temperature change is of course variable and is affected both by the friction between the concrete slab and the subgrade and by wetting and drying of the concrete. The attempt was made in these tests to duplicate the maximum contraction and expansion of a slab free to move, in order to simulate the extreme conditions. Changes in length of 0.090 in. per 100 F temperature change in the plastic rods have been recorded.

A number of types of sealing materials are currently under test, including hot-applied rubberized asphalt, single or two-component mastics, water-emulsion rubberized asphalt, jet-fuel and jet-blast-resistant sealers, and synthetic rubber compounds. Six of the devices are now in operation at the Bureau of Reclamation's laboratories.

Prior to development of the new device, laboratory studies on the be-

havior of joint sealing materials did not predict actual field performance accurately, as the various destructive forces acting upon a joint sealer were studied individually; that is, no single specimen was subjected to all service conditions simultaneously. The effectiveness of the new test procedure was recently established when several materials which performed well under usual laboratory tests failed within a few months when tested in the contraction joint simulator. It is not possible at this time to compare test results from this device with service performance, since it has been in operation less than a year. However, the same type failures produced in service have been produced with this device, usually in a shorter time.

In connection with the contraction joint simulator, the Bureau of Reclamation's laboratories are developing a device to record the frequency and amplitude of expansion-contraction cycles. This device is expected to provide a quantitative basis for comparing the performance of sealing materials.

HENRY JOHNS
U. S. Bureau of Reclamation
Washington, D.C.

The Bookshelf

Dislocations and Mechanical Properties of Crystals

Edited by J. C. Fisher, W. C. Johnston, R. Thomson, and T. Vreeland, Jr.; John Wiley and Sons, Inc., N. Y. (1957); 634 pp.; $15.

THIS VOLUME is a collection of papers and discussions presented at an international conference held at Lake Placid, Sept. 6–8. 1956, under sponsorship of the U. S. Air Force Office of Scientific Research, Air Research and Development Command, and the General Electric Research Laboratory. It is intended to present the most recent research results and ideas on dislocations and mechanical properties of crystals.

Contributions fall under eight general headings: I—Direct Observations of Dislocations; II—Deformation of Pure Single Crystals; III—Work Hardening and Recovery; IV—Alloy Crystals, Impurities, Yield Point Phenomena; V—Dislocation Damping and Fatigue; VI—Theory of Dislocations; VII—Whiskers and Thin Crystals; and VIII—Radiation Damage.

The first contribution, concerned with the direct observation of decorated dislocation patterns in transparent crystals, by S. Amelinck, is a comprehensive review of the research conducted at the University of Ghent. The article illustrates beautifully the dislocation network patterns occurring in transparent solids and analyzes the dislocation networks. Following a resume of the discussion, there are short contributions on potassium chloride and silicon. J. W. Mitchell presents convincing observations on dislocations in silver halides as to polygonization, tilt boundaries, etc. Results of the technique of transmission electron microscopy in observing dislocations in metals developed by the group at Cambridge under P. B. Hirsch are presented with regard to aluminum by P. B. Hirsch, R. W. Horne, and M. J. Whelan. Despite the difficulty in interpreting many of the illustrations, the full impact of the technique in future studies is clearly discernable.

The contribution by Gilman and Johnston on "The Origin and Growth of Glide Bands in LiF Crystals" now makes it possible for workers in the field to obtain in one place the etching and chemical polishing techniques and pertinent results of the exhaustive and well rewarding efforts of both these scientists. Although there are some who will disagree with some of the interpretations presented, none can deny the importance of this work in the over-all portrait of dislocation behavior. Short contributions on metals such as silver and Fe-N crystals together with discussion, present a coordinated story of the visual observations of dislocations.

The second section begins with a comprehensive summary of the low temperature deformation of copper single crystals by T. H. Blewitt. R. R. Coltman, and J. K. Redman. This contribution is concerned with the interesting observation of twinning in copper at low temperatures in addition to the general aspects of the stress-strain curve. Following a short contribution of slip in aluminum, there is a comprehensive summary of slip in potassium chloride crystals.

The third section begins with a detailed and excellent account of glide and work hardening in metals by A. Seeger. Discussion on Seeger's contribution by Friedel plus short contributions by Boas on lattice defects in plastically deformed metals, in addition to discussions on stored energy, climb of dislocations, and substructure effects, make this section one of the most valuable in the volume.

The fourth section begins with contribution by H. Suzuki on the yield strength of binary alloys, and a contribution on the deformation of alloy crystals by Garstone and Honeycombe, carrying with it discussion on many phases of the deformation of alloy crystals. Shorter contributions on subjects such as color-changes occurring in metals upon plastic deformation, diffusion of copper in germanium, pre-yield strain in steel, and yield points in aluminum and nickel, together with discussion by members of the conference end this section.

The section on dislocation damping and fatigue consists of three articles: one on the contribution to internal friction by dislocations by Lucke and Granato, the second on the behavior of metals under reverse stresses, by Mott, and the third, the energy dissipation during fatigue tests by Wadsworth. This section is a little less homogeneous than other sections.

The next section is concerned primarily with dislocation theory. G. Leibfried contributes a section on the thermal motion of dislocation lines. This is followed by a discussion on the interaction of gliding screw dislocations by A. H. Cottrell and on the generation of loops by Fisher. It appears to the writer that one is let down somewhat in this section, perhaps because of the completeness of the earlier sections.

The seventh section, primarily devoted to whiskers and thin crystals, contains an article by Nabarro on the theory of whisker dekinking. The research on whiskers is brought up to date by contributions on the deformation, of silicon, on X-ray investigations in tin, and on the deformation of thin metal crystals.

The final section contains a theory on the formation of cavities along dislocations, by Coulomb and Friedel, plus two contributions detailing the differences of opinion existing on the subject of the annealing of imperfections produced by irradiation with various particles. These contributions are given on the one hand by Koehler, Henderson, and Bredt, and on the other by Blewitt, Coltman, Holmes, and Noggle. The work on the quench hardening of metals is brought up to date by A. H. Cottrell.

To summarize, the contributions are generally on a high level, and as a result the volume will form an invaluable addition to the libraries of metallurgists and solid-state physicists. It is perhaps unfortunate that scientists working in these fields were required to wait about 18 months for the results of many of the leaders in the field.

R. MADDIN

The Measurement of Thickness,

George Keinath, National Bureau of Standards *Circular* 585, U. S. Government Printing Office, Washington 25, D. C. (1958); 79 pp.; 50 cents.

THIS publication surveys the available information on the various methods and problems of measuring thickness that are frequently encountered in science and industry. Measurement of physical parameters involved in the practical measurement of thickness, such as displacement, is covered,

in addition to some more general aspects of the measurement, such as dynamic response. The methods are treated in seven groups, according to physical operating principles; mechanical, chemical, electrical, magnetic, optical, X-ray, and radioactive radiation.

Although the methods and instruments are not described in detail, a discussion of ranges, accuracy, advantages, and limitations is included. One section discusses thickness meters for the blind. A bibliography of references, a limited list of suppliers, and a detailed index of the gages methods, applications, and trade names covered are appended.

Industrial Research Laboratories of the United States

National Academy of Sciences—National Research Council, *Publication 379*, Washington 25, D. C., tenth edition (1956); 584 pp.; $10.

THIS directory lists 4834 industrial research laboratories—an increase of about 45 per cent over the number listed in the previous edition (1950).

The editors have insisted upon a separate and permanently established research staff and equipment as the necessary criteria on for listing a laboratory, thus eliminating firms that do occasional research using teams temporarily recruited for this purpose. Also excluded are Government laboratories including those operated by private contractors. Testing laboratories not engaged in research are also excluded, reference being made to the Directory of Commercial and College Testing Laboratories published by the American Society for Testing Materials in January, 1955.

The entries include the name of the company, the name of the president or responsible manager, the director of the laboratory, and the numbers of personnel in different technical activities. A geographical distribution of the laboratories and a subject index to research activities are included.

Concrete Pipe Handbook

American Concrete Pipe Assn., Chicago, Ill.; second edition; 499 pp.

THE second edition of the Concrete Pipe Handbook brings up to date a wealth of information, both data and otherwise, which was included in the first edition published in 1951. One feature is the inclusion of the completely new revision of the ASTM Specification for Reinforced Concrete Culvert, Storm Drain and Sewer Pipe (C 76 – 57 T).

The contents represent, in concentrated form, experience records and data of the industry. Chapters are included dealing with many phases of the industry, such as the manufacture, bedding and backfilling practice, flow in concrete conduits, and runoff, among others. A new chapter on autogenous healing of concrete is included as well as an additional appendix section on design and installation criteria for reinforced concrete pipe culverts.

The Direction of Research Establishments

Proceedings of the symposium, National Physical Laboratory, Teddington, Middlesex, England, September 26–28, 1956; The Philosophical Library, Inc., 15 E. 40th St., New York, N. Y.; $12.

THE first international symposium of this subject held in England is reported in full. The volume presents the 20 papers given at the three-day symposium together with summaries of the discussions of each. The papers cover a gamut of research direction problems. Discussion ranges from organization and control of both large and small establishments to choice and termination of projects, research buildings and facilities, scientific creativity, personnel selection, assessment and incentives, internal and external communication, and, finally the determination of results.

In the eyes of a thoroughly industrialized American scientist, the book leaves an impression which may not be intended. The symposium was attended by some 175 research administrators from 16 countries. About two-thirds of these were from Britain. Of those attending, over half were in government service, about twenty from trade associations and twenty from universities or "contract" research establishments. Less than one-fourth of the conferees were representing private enterprise. Is it any wonder, then, that an urge to share all research knowledge seems to recur?

Nevertheless, this record is recommended reading for (1) top executives not associated with research but who need or want to know something of the many difficulties, human and otherwise, connected with this vital activity, (2) heads of departments (nonresearch) who must rub elbows with us but do not understand that research direction is difficult, *too*, and (3) recent or junior research administrators who have not yet had to face (and soothe or solve) the many administrative research problems discussed at the symposium. Indeed, even the experienced research director may find solace here in learning that his own problems are not unique and have been recognized by others.

Sutherland in his opening address questions the optimum size for a research laboratory and the place of sponsored research in the effort. Is direction of research a science or an art?

Bernal justly points out that finding the problem is the problem—once found, the solution is simplified. He also highlights the anomaly in university research—the demand by industry for application in return for industry support and the demand by university for basic work to further the teaching effort. Jackson discusses the choice and termination of research projects.

Creativity of the scientist, generally, is the subject of the second session. Stein shows how sociological and psychological pressures influence the creative force. Van Lennep discusses personality and social factors (and management policies) and how these relate to the creative drive. Willson, in a not unrelated paper, discusses budgets and administrative controls and how research personalities may react under too rigid external restriction.

In the third session, general organization is discussed in four papers. Hiscocks traces the evolution of research purpose, method, and organization. Vieweg gives us advice on organization of the research workshop. Lea and Snow discuss the research building—what is required and how should we lay out, design, and construct it.

The next session deals broadly with questions of how to obtain, assess, organize and handle, and motivate the best research personnel. Bristowe and Rosser in separate papers describe selection and personnel assessment procedures. Shepard compares traditional theories of industrial organization with new or growing traditions and comparable traditions of scientific organization. Harington describes staff groupings and the flow of authority as these apply to medical research. Mayne talks about incentives as they apply to scientific personnel—he does not ask us to agree with him; (and this reviewer does not—but he makes the true observation that the problem is "how serious are we in our opinions about incentives and what are we going to do about them?"

An interesting session on communication followed, led off by Williams on internal communications in a large laboratory. His interesting ideas on organization to assist communication appear to be working. Moss and Wilkins describe sources of information and communication in smaller research establishments together with a survey of technical people about their information source habits. Green and Dodd describe the importance of various means of oral and written communication. In 1956, of course, the last word could not be said about electronic transmittal or recall! Garratt talks about extramural communications and points out that today, with so varied scientific disciplines, we must be sure we are talking the same language. Thistle gives an interesting paper about the difficulties of popularizing science to various segments of society. He gives no special formula for use on our own boards of directors.

Wilson, in the final paper, lays down some criteria for the assessment of the work of a laboratory. Of course, there is no firm answer in this as in most other areas of research establishment direction.

W. M. COOPER

(*Continued on page 74*)

PROFESSIONAL CARDS

Commercial Testing, Research, and Services

- Chemical
- Metallurgical
- Physical
- Radiographic
- Spectrographic
- Sampling

The Bookshelf

(*Continued from page 69*)

Fiftieth Anniversary History, American Concrete Pipe Assn.

Howard F. Peckworth, American Concrete Pipe Assn., Chicago, Ill.; 122 pp.

THE experiences and personalities involved in the growth and activities of the first fifty years of the American Concrete Pipe Assn., since its inception in 1907, are presented in a very interesting and graphic manner in a recent book prepared by Howard F. Peckworth, managing director. These experiences closely parallel the experiences and evolution of the construction industry for that period.

In the desire for a uniformly high-quality product, it was recognized at the start that the need could only be satisfied by standard national specifications. Advantage was promptly taken of the early work in research on concrete pipe of such well-known authorities as Dean A. N. Talbot of the University of Illinois, Dean Anson Marston of Iowa State College, and Prof. Dalton G. Miller at the University of Minnesota.

The technical development and standardization activities were closely related and coordinated right from the start with the work of ASTM Committee C-4 on Clay Pipe, organized in 1904, and later with ASTM Committee C-13 on Concrete Pipe, organized in 1931.

Presented throughout the book are references to the men who played a part in the development of the industry and, as Mr. Peckworth states, "The history of the Association is the history and influences of strong men who made it."

Springs, A Bibliography

Compiled by the Research Committee of the Associated Spring Corp.; The University of Michigan, Engineering Research Institute, Ann Arbor, Mich.; paper covered, 386 mimeographed pages.

THIS book is a compilation of abstracts of articles dealing with springs. The abstracts were obtained from those published by various abstracting services through 1956.

The references are grouped chronologically as they appeared in the reference sources. This does not necessarily mean that the year in which the subjects originally appeared is the same as the one in which they are listed in the bibliography, since abstracting and publication of reference involves a necessary time lag. This is particularly true in the case of foreign articles. In any event, this chronological arrangement provides a rough indexing by years. Complete author and subject indexes are provided at the end of the bibliography. Patents are indicated in the author index by the letter P following the page reference.

Papers from Joint Meeting on Cotton

"PROCEEDINGS of the Joint Meeting of the Cotton Improvement Committee of Texas and the Southwest District of the American Society for Testing Materials" is now available. The booklet contains five of the six papers presented at the meeting. The lecture given at the meeting by Richard T. Kropf, President of the Society, is not included in the publication. The meeting took place in Houston, Tex., February 3, 1958.

Among the papers are: "Appraisal of Hybrids Between Species as Material for Cotton Improvement," by C. F. Lewis; "Textile Testing Instruments—the Tools of Technologists," by Cameron A. Baker; "American Cotton's Position in World Commerce," by Harmon A. Whittington; "Research Improves the Usefulness and Attractiveness of Cotton Products," by C. H. Fisher; "How Dupont 420 Nylon Helps Cotton to Stretch the Working Man's Budget," by Paul C. West. Copies of the *Proceedings* may be obtained directly from Dr. Earl E. Berkley, Director, Fiber Laboratory, Anderson, Clayton and Co., Box 2538, Houston 1, Tex., at $2 each.

46 pages, 8½ by 11 in., paper cover.

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The Bookshelf

(Continued from page 74)

Managements' Stake in Standards

INTER-INDUSTRY relationships have become so complex that a company's standards must be consistent with the standards of its supplying and consuming industries, the National Industrial Conference Board reports after a survey of over 100 companies and several hundred trade associations.

In a 72-page report, "Industrial Standardization Report 85," it was emphasized that the business management of American industrial efficiency could never have been obtained without standardization. The standardization referred to includes not only material standards, but also product, component, purchasing, production, equipment, safety, and administrative standards.

Significantly, national standards appear to play an important role since they serve as the basis for many corporate standards. Few executives care to have all their company standards formulated internally even when possible. The study reveals that there was nearly a unanimous expression of interest in the standardizing activities of national corporations whether or not the individual companies participated.

The report, which contains nine individual case histories, reviews the nature and the use of industrial standards and company standards utilization. Such details as the significance to management, practical advantages, and classification of standards are described. Of particular interest to management, this study outlines the arrangements used by corporations in setting up standardizing boards.

The report, while written in general terms, is a significant contribution to managements understanding of standardization. The study was compiled for the Board by assistant professor of business administration Jack Rogers of the University of California and has as its stated purpose "assistance to the Board's Associates in appraising and improving their own standardization programs. . .it contains a series of case histories that should provide both information and guidance to those seeking help in this area."

OTS Research Reports

THESE reports, recently made available to the public, can be obtained from the Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C. Order by number.

Test of 61S-T6 Aluminum Sheet under Short-Duration, High Rate of Rise, Heating. AEC, SCTM-3-58(16), 50 cents.

Bevatron Operation and Development, XIV. May, June, July, 1957. AEC, UCRL-8022, 75 cents.

Nuclear Physics Research Quarterly Reports —July, August, September, 1957. HW-53492, $1; October, November, December, 1957. AED, HW-54591, $2.25.

Reactor Physics Primer. AEC, HW-51856, $2.50.

The Measurement of Thermal Properties of Nonmetallic Materials at Elevated Temperatures: Final Report. AEC, ORO-170, $1.75.

Metallurgy Division Quarterly Report for January, February, and March, 1956. AEC, ANL-5563, 50 cents.

Welding of Inconel "X." AEC, TID-8015, 50 cents.

A Bibliography of Diffusion of Gases, Liquids and Solids in Solids. AEC, TID-3071, $3.50.

A Glass-Metal Vacuum System. AEC, MLM-1015, 50 cents.

Analytical Chemistry Division Annual Progress Report for Period Ending December 31, 1957. AEC, ORNL-2453, $2.75.

Heats of Sublimation of the Elements. AEC, UCRL-2854 (2nd Rev.), 50 cents.

Development of Isotope Production in the USSR, AEC-tr-3093, 50 cents.

Thermal Properties of High Temperature Materials. PB 131718, $2.25.

Evaluation of Crack Susceptibility Tests. PB 131348, $1.25.

Intermediate Phases in the Iron-Tungsten and Cobalt-Tungsten Binary Systems. PB 131627, 75 cents.

Sodium Silicates for the CO_2 Process. Bonding of Foundry Sands. PB 131642, 50 cents.

Guide to Electrodeposited Coatings and Other Surface Treatments for Metals. PB 131496, 75 cents.

Development of Oxidation and Liquid Sodium Resistant Brazing Alloys. PB 131745, $1.25.

Development of Electroplating Processes to Eliminate Hydrogen Embrittlement in High-Strength Steel. PB 131721, $2.25.

Phosphating Treatments—Patent Literature Survey. PB 131356, $3.75.

Radiographic Standards for Bronze Castings. PB 131854, $25.

Effective Thickness of Chromium Plate on the Sensitivity of Magnetic Particle Inspection. PB 131608, 50 cents.

Phase Relationships in Magnesium Alloys. PB 131622, $1.

Development of ZM41 Magnesium Sheet Alloy. PB 131417, 75 cents.

Investigation of Alloys of Magnesium and Their Properties: Part 2—Thermal and Electrical Properties of Magnesium Base Alloys. PB 131436, 75 cents.

Investigation of Alloys of Magnesium and Their Properties: Part 3—Development of Preferred Orientation in Wrought Magnesium Alloys. PB 131437, $1.

Test Methods for Magnesium Surface Treatments. PB 131600, $1.75.

A Basic Study of Corrosion of Magnesium. PB 131662, $1.50.

Electrochemical Mechanisms of Noble-Metal/Hydrogen Systems: Part 1—Platinum. PB 131526, $1.

Research on the Effects of Stress, Strain, and Temperature on the Eutectoid Decomposition of Titanium Alloys. PB 131610, $2.

Partition of Soluble Carbon in Ti-6Al-4V Alloy. PB 131603, $2.

Study of Microdistribution of Interstitial Elements in Titanium by Internal Friction Techniques. PB 131613, $1.50.

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PERSONALS...

News items concerning the activities of our members will be welcomed for inclusion in this column

Lynn S. Beedle professor of civil engineering, Lehigh University, received the American Welding Society's A. F. Davis Silver Medal for a joint paper with George C. Driscoll. The paper was titled "The Plastic Behavior of Structural Members and Fames."

James E. Bennett, Jr., formerly with F. C. Torkelson Co., Idaho Falls, Idaho, is now assistant manager, Concrete Control, Uhl, Hall, & Rich, Niagara Falls, N.Y.

Elmer O. Bergman, who recently retired as technical adviser, C. F. Braun and Co., Alhambra, Calif., is continuing his interest in ASTM and the activities of certain of the metals groups through personal affiliation. He has offices as consulting engineer at 785 Winthrop Rd., San Marino, Calif.

Robert D. Bonney, retired vice-president and director, Congoleum-Nairn, Inc., was elected an honorary member of the Philadelphia Paint and Varnish Production Club. Mr. Bonney is a past-president of the Philadelphia Club, also of the New York Paint and Varnish Production Club. A loyal, long-time member of ASTM, he has been very active in technical and administrative work of the Society, serving two terms on the Board of Directors, as a member of the Administrative Committee on End-Use Products since 1946, and as chairman of the Administrative Committee on Standards for a number of years.

C. E. Brandon, formerly assistant technical director, Howard Paper Mills, Inc., Dayton, Ohio, is now on the faculty of Miami University, Oxford, Ohio.

Wallace R. Brode, science adviser to the U. S. Secretary of State, received an honorary doctor of science degree from Ohio State University, being cited for "significant contributions to the advancement of science in this nation and throughout the world" and for "distinguished and continuing services to science, to higher education, to his government, and to his fellow-men."

E. H. Bunce, retired as technical assistant to the president, The New Jersey Zinc Co., New York City. Mr. Bunce has represented his company for many years in the Society and on Committee B-2 on Non-Ferrous Metals and Alloys, serving as vice-chairman of this committee.

George D. Calkins, formerly assistant division chief, Battelle Memorial Inst., Columbus, Ohio, is now assistant group leader, Fuel Element Development, Atomics International Division, North American Aviation, Inc., Canoga Park, Calif. Dr. Calkins has been serving as a member of ASTM Special Administrative Committee on Nuclear Problems.

Gerald G. Christiansen, until recently with L. Sonneborn Sons, Inc., has opened offices as consultant on cement technology at 1340 Lombard St., San Francisco, Calif.

Marc Darrin retired as associate director of research, Solvay Process Division, Allied Chemical Corp., Baltimore, Md. Mr. Darrin, who has represented his company for many years on several technical committees plans to continue his interest in ASTM activities through affiliation. He has served as chairman of Committee A-5 on Corrosion of Iron and Steel for the past two years. Mr. Darrin resides at 4401 Wickford Rd., Baltimore.

Lawrence A. DuBose, formerly on the faculty of the University of Alabama, Civil Engineering Dept., has accepted a position as director of engineering, Testing Service Corp., Lombard, Ill.

R. P. Dinsmore, vice-president of research and development, Goodyear Tire and Rubber Co., Akron, Ohio, received a special citation from Indiana Technical College for "outstanding contributions to industrial development through management, science, and engineering." Mr. Dinsmore has served for many years on ASTM Committee D-11 on Rubber.

Charles M. Gambrill, manager, Analytical Research and Services, Research Laboratories, Ethyl Corp., Detroit, Mich., will receive the 1958 Anachem Award on October 7 in Detroit. This honor is accorded each year by this associate group of the Detroit Section, American Chemical Society, recognizing service to analytical chemistry through research, administration, teaching, or other activities. Mr. Gambrill is very active on Committee D-2 in Petroleum Products and Lubricants, serving as chairman of the Research Division III on Elemental Analysis which sponsors a number of outstanding technical presentations. He has just retired as chairman of the ASTM Administrative Committee on District Activities, and has been an active member of the Detroit District.

Frederick Graebe, formerly with the U. S. Army, is now assistant bridge engineer, Division of Highways, State of California.

James A. Harding, until recently with Rotex Punch Co., San Leandro, has accepted a position as staff coordinator, Victor Equipment Co., San Francisco, Calif.

John H. Hickey, formerly with Pittsburgh Coke and Chemical Co., Chemical Plants Division, is now chief chemist, Polymer Chemicals Division, W. R. Grace and Co., Baton Rouge, La.

S. C. Hollister, dean of engineering at Cornell University, Ithaca, N. Y., received a doctor of engineering degree from Lehigh University.

Ernest Howard has accepted a position as product specialist, Metals and Controls Corp., Attleboro, Mass. He had been associated with Wade Electric Products Co., Sturgis, Mich.

Harry J. Huester, Commander, USNR, has been reinstated (following temporary retirement) in the Bureau of Aeronautics, Technical Data Division, Washington, D. C., being assigned to Military Standardization Programming.

Kenneth A. Kaufman, formerly with Spencer Chemical Co., Kansas City, Mo., is now supervisor, Market Research and Development, Plastics and Resins, Amoco Chemical Co., Chicago, Ill.

Eugene P. Klier, until recently on the faculty of Syracuse University, has been appointed staff metallurgist, National Academy of Sciences, National Research Council, also metallurgist, Naval Research Laboratory, Washington, D. C.

Henry A. Lepper, Jr., formerly on the faculty of Yale University School of Engineering, is now associate professor, Civil Engineering Dept., University of Maryland.

G. H. Mains recently retired as director, Research and Development Laboratory, National Vulcanized Fibre Co., Wilmington, Del. A loyal supporter of ASTM activities for many years as representative of his company, Mr. Mains is continuing his interest through personal affiliation. Presently engaged as plastics consultant, he may be addressed at Marshall Heights, Yorklyn, Del.

Alex. M. Miller, has accepted a position with International Latex Corp., Dover, Del. He was formerly with Rayco Manufacturing Co., Paterson, N. J.

J. Kelly Moffitt, until recently materials engineer, Colorado Materials Co., Colorado Springs, Colo, is with Salt Lake City Corp. in a similar capacity.

M. D. Morris, is now vice-president in charge of engineering and sales for the TESTlab Corp. (offices in Chicago and New York City), manufacturers and marketers of physical testing apparatus for soils, bituminous, and concrete materials.

Maurice A. Murray, formerly chief ceramic engineer, The B. G. Corp., Ridgefield, N. J., is now senior industrial engineer, Clevite Electronics Co., Bedford, Ohio.

Robert T. O'Conner, Leo A. Goldblatt, and **Jack Simpson** were among a group of employees of the Southern Utilization Research and Development Division (New Orleans) of the Agricultural Research Service recognized by the U. S. Department of Agriculture for developments in the process of manufacturing synthetic rubber, improved methods in the manufacture of cotton textiles, and in the industrialization of tung oil products, and for notable advances in the analysis of agricultural products for their chemical components. Mr. O'Connor received the Distinguished Service Award, the highest honor conferred by the Department; and Messrs. Goldblatt and Simpson received Superior Service Awards. All three are active in ASTM technical committee work; Mr. O'Connor heads the subcommittee concerned with methods of Committee E-13 on Absorption Spectroscopy.

Sidney Stiefler, formerly with The Wool Bureau, New York, N. Y., is now with the United States Testing Co., Hoboken, N. J.

Aston M. Tenney, retired as vice-president, Eastman Chemical Products, Inc., New York, N. Y. Mr. Tenney had served on Committee D-13 on Textile Materials for many years.

Robert L. Terrill, formerly production superintendent, Spencer Kellogg and Sons, Inc., Buffalo, N. Y., has been elected vice-president of research and development of his company. Mr. Terrill, who has represented Spencer Kellogg in ASTM and on Committee D-1 on Paint since 1945, has been very active for the past three years in the Western New York-Ontario District Council, just completing a term as secretary of this local group, and elected at the recent ASTM Annual Meeting as vice-chairman of the district.

B. A. Vallerga, division managing engineer, The Asphalt Inst., is opening a new Pacific Coast Division headquarters at Berkeley, Calif. He will direct Institute engineering services for the States of Washington, Oregon, California, and Arizona.

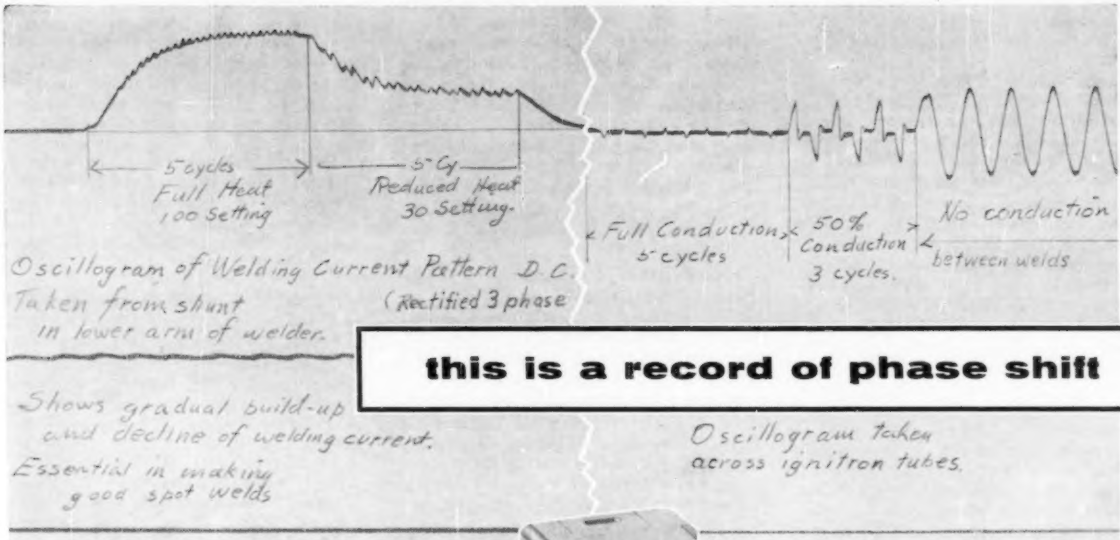
Clarence F. VanEpps, formerly manager, Materials Engineering Dept., Stromberg-Carlson Co., Rochester, N. Y., is director of manufacturing, Electronics Division.

George L. Otterson, formerly assistant technical director, Marquette Cement Manufacturing Co., Chicago, Ill., is now construction management engineer, U. S. Army Engineer District, Omaha, Nebr.

R. H. Rimmer, retired as director of research, Aluminium Laboratories, Ltd., Montreal, Canada.

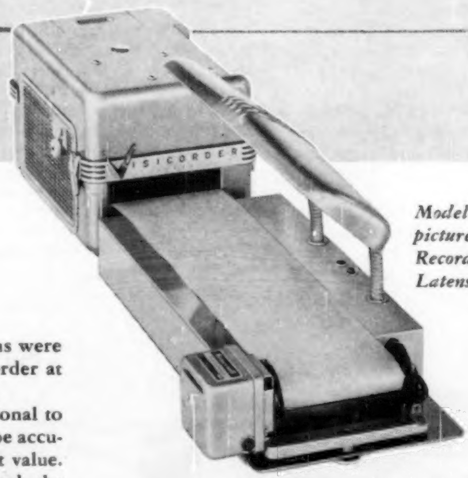
William K. Sandmeyer, retired as assistant to general sales manager, Cyclone Fence Dept., American Steel and Wire Division, United States Steel Corp., Waukegan, Ill., after total service with Cyclone for more than 45 years. Mr. Sandmeyer had been serving on ASTM Committee A-5 on Corrosion of Iron and Steel. **W. W. Fuller,** Cyclone general superintendent production, is assuming membership in the Society, and has been accepted as a member of Committee A-5.

(*Continued on page 82*)



this is a record of phase shift

Visicorder Record — 2/3 actual size



Model 906A Visicorder pictured with Record Takeup and Latensifier Unit.

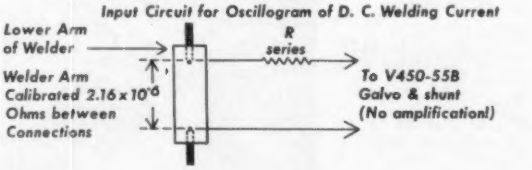
These welder phase-shift heat-control patterns were directly recorded with a Honeywell 906 Visicorder at Bristol Aircraft (Western) Limited in Winnipeg.

Since the welding heat generated is proportional to the square of the current value, phase shift must be accurately controlled in order to determine the heat value. If the phase shift dial is not accurately calibrated, the result is too much or too little heat, and a poor weld.

In this application, the Visicorder is an essential guide to accurate calibration, since ink-type recorders do not cover the sensitivities and frequencies needed and an oscilloscope would present a continually changing pattern since most recording periods are less than 10 cycles. The directly-recorded Visicorder patterns allow a convenient study of the exact time when the current wave form was being cut off.

Here is the circuit used in this test.

Input Circuit for Oscillogram of D. C. Welding Current



The Honeywell Visicorder is the first high-frequency, high-sensitivity direct recording oscillograph. In laboratories and in the field everywhere, instantly-readable Visicorder records are pointing the way to new advances in product design, rocketry, computing, control, nucleonics . . . in any field where high speed variables are under study.

The new Model 906A Visicorder, now available in 8- and 14-channel models, produces longitudinal grid lines simultaneously with the dynamic traces, time lines, and trace identification by means of new Accessory units.

To record high frequency variables—and monitor them as they are recorded—use the Visicorder Oscillograph. Call your nearest Minneapolis-Honeywell Industrial Sales Office for a demonstration.

Honeywell

Industrial Products Group

Reference Data: Write for Visicorder Bulletin

Minneapolis Honeywell Regulator Co., Industrial Products Group, Heiland Division, 5200 E. Evans Avenue, Denver 22, Colorado

FOR FURTHER INFORMATION CIRCLE 992 ON READER SERVICE CARD

(*Continued from page 80*)

A. O. Schaefer, president, Pencoyd Steel and Forge Corp., Philadelphia, Pa.; former ASTM national director, and a past-president of ASM, has accepted appointment by the Board of Trustees of the American Society for Metals to the unexpired term of secretary of ASM, following the recent death of founder-member William H. Eisenman, who for 40 years had served as national secretary. The ASM Trustees have asked approval of the membership that in the future the position of secretary be an elective one, with the actual management carried on by a managing director to be appointed by the Trustees. **Ray T. Bayless,** for many years ASM assistant secretary, has been appointed manager pro tem, a position also formerly held by Mr. Eisenman. Mr. Bayless has been active in ASTM District work for more than 20 years, serving terms as chairman and secretary of the Cleveland Council. Other ASTM members among nominees for 1958–59 ASM officers: **C. H. Lorig,** technical director, Battelle Memorial Inst., for president; and **Earl R. Parker,** University of California (Berkeley), ASM trustee. **Ernest E. Thum** is one of five ASM staff members to be appointed to the advisory council.

Paul Schall, Jr. has been named chief of the Radioisotopes and Radiation Division, Battelle Memorial Inst., with responsibility for the operation of the research center's radioisotope laboratory and gamma-irradiation facility. **James B. Whitney** has been appointed chief of the High-Level Radiation Division, specializing in studies involving highly radioactive materials, particularly those requiring Battelles hot-cell laboratory facilities. Both gentlemen are very active in ASTM Committee E-10 on Radioisotopes and Radiation Effects.

Henry Shaw, formerly chemical engineer, The Babcock & Wilcox Co., Atomic Energy Division, Lynchburg, Va., is now engineer officer (Lt.), Co. "B" 91st Engineer Battalion (Combat), Fort Belvoir, Va.

Maurice J. Sinnott, associate professor, Chemical and Metallurgical Engineering Dept., University of Michigan, Ann Arbor, has been appointed a member of the executive committee for the newly formed University of Michigan Research Institute.

J. Steart Stein, Chicago architect, member of the firm of Sobel-Stein, architects and engineers, was elected National President of the Construction Specifications Inst. **Harry Plummer,** director of engineering and research, Structural Clay Products Inst., Washington, D. C., was elected CSI Secretary-Treasurer; and **H. T. J. Martin,** architect and engineer, Dallas, Tex., and **Frank L. Couch,** professional engineer, Detroit, Mich., were among the new directors named.

C. J. Van Til has accepted appointment as office engineer, The Asphalt Inst., Berkeley, Calif. He formerly was associated with the Western Asphalt Roofing Manufacturers Assn. in the same city.

J. York Welborn, previously director, Natural Rubber Bureau Laboratory, Arlington, Va., has been named chief, Bituminous Branch, Division of Physical Research, Bureau of Public Roads, Washington, D. C.

Russell P. Westerhoff, a vice-president of Ford, Bacon, & Davis, Inc., New York City firm management consultants and engineers, has been named to a two-year term as a director of the National Society of Professional Engineers, to represent the New Jersey Society of Professional Engineers.

E. G. White, city chemist, City Council Laboratory, Johannesburg, South Africa, received the degree of Doctor of Philosophy from the University of Witwaterstand.

W. Clifford Witham has been appointed assistant director, in charge of industrial relations, at the Northern Regional Research Laboratory, U. S. Department of Agriculture, Peoria, Ill. This is a new position, created in line with the national emphasis on utilization research—es-

(*Continued on page 84*)

(*Continued from page 82*)

pecially the development of industrial uses for cereal grains and oilseeds. For the past three years Dr. Witham had been assistant manager for program coordination at Armour Research Foundation. Previously he was for many years chief of the specialty oil products development section at Sun Oil Co., Marcus Hook, Pa. He has been very active in a number of the technical committees of ASTM Committee D-2 on Petroleum Products and Lubricants, heading certain of the subgroups.

J. E. Yewell recently retired as chief engineer, Bessemer & Lake Erie Railroad Co., Greenville, Pa.

J. G. Zeitlen has been elected Dean of the faculty of civil engineering at Technion, Haifa, Israel. Mr. Zeitlen, United Nations expert in soil mechanics, has initiated several soil mechanics research projects since he went to Israel in 1953 and has played an active part in the establishment of a Soil and Engineering Division at Technion.

DEATHS...

Robert F. Blanks, vice-president and general manager, Great Western Aggregates, Inc., and research consultant, Ideal Cement Co., Denver, Colo. (former chief, 1930 to 1951, Research and Geology Division, U. S. Bureau of Reclamation), died July 14, 1958. A very active member of ASTM since 1932, Mr. Blanks had made valued contributions through the years to the work of several of the technical committees including C-1 on Cement, C-9 on Concrete and Concrete Aggregates, and D-18 on Soils for Engineering Purposes, giving unstintingly of knowledge gained from his long experience on irrigation and construction projects. He served for three years as secretary of Committee D-18. He also rendered helpful service through vigorous support of the Society's first Pacific Area National Meeting in 1949 in San Francisco.

Samuel S. Gutkin, sales manager and technical director, Cargill, Inc., Philadelphia, Pa., died June 2, 1958. A member of ASTM since 1953, Mr. Gutkin had been serving on Committee D-1 on Paint, Varnish, Lacquer, and Related Products.

John Lansford McCloud, retired director of chemical engineering and chemical and metallurgical research, and staff consultant, Ford Motor Co., Dearborn, Mich., and recently consulting editor of *Metal Progress*, died July 26, 1958, following a heart attack. Affiliated since 1924, Mr. McCloud had rendered valued service to the Society in various areas, serving on the Board of Directors, the Detroit District Council, and on a number of the technical committees. At the recent Annual Meeting he was elected to ASTM Honorary Membership, in recognition of "long-time and notable contributions to research and standards for materials, especially in the automotive field, and for loyal sustained support of the Society" (see ASTM BULLETIN, July 1958, p. 25). Since 1956 Mr. McCloud had resided at Los Altos, Calif.

J. M. Schantz, Hercules Powder Co., Wilmington, Del., died July 29, 1958. He was a long-time member of Committees D-1 on Paint, and D-17 on Naval Stores, serving as chairman of D-17 Subcommittee I on Softening Point of Rosin.

H. W. Schlenker, Reichhold Chemicals, Ind., Eastern Resin Division, Elizabeth, N.J., died June 6, 1958. Mr. Schlenker represented his company on Committee D-1 on Paint.

Tsukumo Tomonari, Kurashiki Rayon Co., Ltd., Osaka, Japan, died December, 1957. He was a member since 1950.

Robert T. Wood, chief metallurgist, Magnesium Section, Metallurgical Division, Aluminum Company of America, Pittsburgh, Pa., died May 4, 1958. He had represented his company for many years on Committees B-6 on Die-Cast Metals and Alloys, and B-7 on Light Metals and Alloys, Cast and Wrought.

NEW MEMBERS.......

The following 189 members were elected from June 12 to August 13, 1958, making the total membership 9460 .... Welcome to ASTM

Note—Names are arranged alphabetically—Company members first then individuals—Your ASTM Year Book shows the areas covered by the respective Districts

CENTRAL NEW YORK DISTRICT

Johnson, Charles K., sales engineer, Baldwin-Lima-Hamilton Corp., 509 State St., Schenectady, N. Y.

New York State Department of Public Works, Division of Construction, deputy chief engineer (Highways), Fifteenth Fl., Gov. A. E. Smith State Office Bldg., Albany, 1. N. Y.

CHICAGO DISTRICT

Guardian Electric Manufacturing Co., E. T. Sliwinski, engineer, 1621 W. Walnut St., Chicago 12, Ill.

Berg, Robert, H., owner, Process Control Services Co., 196 Clinton Ave., Elmhurst, Ill.

Boyes, G. M., control engineer, Wisconsin Wire Works, Box 767, Appleton, Wis.

Cohen, Jacques, 509 S. Fifth, Apt. 15, Champaign, Ill. [A]*

Ewing, Lloyd, vice-president, Kyova Fiber Pipe Co., 6200 N. Thirty-ninth St., Milwaukee 9, Wis.

* [A] Associate Member.

Fuller, W. W., general superintendent-production, Cyclone Fence Dept., American Steel and Wire Div., United States Steel Corp., Box 260, Waukegan 1, Ill.

Jones, Rudard, A., director; research professor of architecture, Small Homes Council, University of Illinois, Urbana, Ill. For mail: 209 E. Mumford Dr., Urbana, Ill.

Klieger, Paul, Applied Research Section, Research Dept., Portland Cement Assn., 33 W. Grand Ave., Chicago 10, Ill.

Larson, Stanley F., Artco, Inc., 9120 S. Park Ave., Chicago 19, Ill.

Lubeck, Donald G., wood technologist, Hammond Organ Co., 2915 N. Western Ave., Chicago 18, Ill.

Mein, James H., manager, Sales Engineering, Masonite Corp., 111 W. Washington St., Chicago 2, Ill.

Perkins, R. B., supervisor of technical service, Amoco Chemicals Corp., 910 S. Michigan Ave., Chicago 80, Ill. For mail: 3201 S. Michigan Ave., Chicago 16, Ill.

Pierce, H. D., owner, Universal Wire and Cable Co., 2929 N. Paulina, Chicago 13, Ill.

Philleo, Robert E., research engineer, Fire Research Section, Portland Cement Assn., 33. W. Grand Ave., Chicago 10, Ill.

Round, Byron J., manager of engineering, Combustion Engineering, Inc., 425 W. 151st St., East Chicago, Ind.

Schmidt, William, structural engineer, 2834 W. Addison St., Chicago 18, Ill.

Semenek, Michael P., testing equipment designer, International Harvester Co., 2626 W. Thirty-first Blvd., Chicago 8, Ill. For mail: 4237 Oak Ave., Brookfield, Ill.

Shook, James F., materials engineer, Highway Research Board, AASHO Road Test, Box 539 Ottawa, Ill.

Weisz, Robert G., group leader, Amoco Chemicals Corp., 910 S. Michigan Ave., Chicago 80, Ill. For mail: 3201 S. Michigan Ave., Chicago 16, Ill.

CLEVELAND DISTRICT

Hamilton Kent Manufacturing Co., T. S. Rowe, president, Box 178, Kent, Ohio.

Clow, Samuel C., plant manager, James B. Clow and Son, Inc., Coshocton, Ohio.

Evans, Robert M., technical director, The Master Mechanics Co., 2097 Columbus Rd., Cleveland 13, Ohio.

Gilbert, Lyman F., supervisor, Basic Measurements, Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.

Gude, William G., managing editor, FOUNDRY, Penton Bldg., Cleveland 13, Ohio.

Lafferty, W. M., chief engineer, United States Concrete Pipe Co., Box 68, Uhrichsville, Ohio.

McBroom, Elton, manager of engineering, The Premier Autoware Co., 4415 Euclid Ave., Cleveland 15, Ohio.

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(*Continued from page 86*)

Miller, Harold J., chief engineer, Eagle Crusher Co., 900 Highway, E., Galion, Ohio. For mail: 423 Erie St., Galion, Ohio.

Simmons, John W., executive vice-president, The Wilson Rubber Co., 1200 Garfield Ave., S.W., Canton 6, Ohio.

DETROIT DISTRICT

Johnson, A. Morgan, president, Civil Engineers, Inc., 12800 Fenkell, Detroit 27, Mich.

NEW ENGLAND DISTRICT

Batty, William R., Jr., sales manager, Standard Nut and Bolt Co., Valley Falls, R. I.

Becker, Robert M., partner, Linenthal & Becker, 16 Lincoln St., Boston 11, Mass.

Carter, Seymour W., engineer, C. T. Morgan Co., 21 Lothrop St., Beverly, Mass. For mail: Maple St., Sherborn, Mass.

Chew, Harvey Lincoln, senior chemist, CBS—Hytron, Inc., 100 Endicott St., Danvers, Mass.

Gleason, Carl B., senior metallurgist, General Electric Co., Aircraft Accessory Turbine Dept., 950 Western Ave., West Lynn 3, Mass.

LaCave, Jack P., general manager, Piolite Div. of Pioneer Plastics Corp., 28 Goodhue St., Salem, Mass.

McKeown, George, general superintendent, Moore Drop Forging Co., 38 Walter St., Springfield 7, Mass.

Melcher, George H., town engineer, Administration Bldg., Swampscott, Mass.

Millard, Junius W., research director, Mechanical Engineering Div., Quartermaster Research and Engineering Command, Natick, Mass.

O'Neil, Joseph E., research and materials engineer, Research and Materials Div., The Commonwealth of Massachusetts, 99 Worcester St., Wellesley Hills 81, Mass.

Parlanti, Conrad A., president, Niforge Corp., 677 Beacon St., Boston 15, Mass.

Read, T. I., director of research, The Russell Manufacturing Co., 400 E. Main St., Middletown, Conn.

Schroeder, Richard E., libability engineer, American Mutual Liability Insurance Co., Wakefield, Mass.

Silverman, Leslie, professor of engineering in environmental hygiene, Harvard University, School of Public Health and Graduate School, 55 Shattuck St., Boston 15, Mass.

Sommer, William J., metallurgist, Plainville Casting Co., Plainville, Conn.

Tisch, Arthur S., Technical Service Dept., Independent Nail and Packing Co., 106 Hale St., Bridgewater, Mass.

NEW YORK DISTRICT

Associated Testing Laboratories, Inc., William Tonkowich, president, Clinton Rd., Caldwell, N. J.

Borneo Sumatra Trading Co., Inc., David S. Malka, manager, 120 Wall St., Rm. 710, New York 5, N. Y.

Building Stone Inst., Frank P. Tufaro, executive secretary, 420 Lexington Ave., New York 17, N. Y.

Chemical Construction Corp., R. W. Tirrell, manager of engineering services and drafting, 525 W. Forty-third St., New York 36, N. Y.

Construction Management Corp., John Molloy, president, 26 Broadway, New York 4, N. Y.

Ford, Bacon & Davis, Inc., Julian Narki, chief mechanical engineer, 39 Broadway, New York 6, N. Y.

Huber, J. M., Corp., Claude F. Geffken, laboratory manager, 1478 Chestnut Ave., Hillside, N. J.

Italit, Inc., George J. Feskoe, vice-president, 620 Fifth Ave., New York 19, N. Y.

Blumberg, Harry S., consulting metallurgist, 78 Irving Pl., New York 3, N. Y.

Buchanan, W. Franklin, boro engineer, Boro of Metuchen, 495 Main St., Metuchen, N. J.

Cantlin, John H., vice-president and director of engineering, The Wilcolator Co., 1001 Newark Ave., Elizabeth B, N. J.

Dutchess County Highway Dept., Charles H. O'Brien, county superintendent of highways, 38 Dutchess Turnpike, Box 1307, Poughkeepsie, N. Y.

Edmunds, Edward E., executive vice-president, Molecu Wire Corp., Eatontown, Freehold Pike, Scobeyville, N. J.

Eisenberg, Melvin, project engineer, General Ceramics Corp., Keasbey, N. J.

Finkel, Irving, quality assurance engineer, HatfieldWire and Cable Div., Continental Copper and Steel Industries, Inc., 487 Hillside Ave., Hillside, N. J.

Fong, Henry Lee, chief chemist, Wah Chang Smelting and Refining Corp., 63 Herbhill Rd., Glen Cove, N. Y.

French, Arthur Ralph, chief inspector and metal control, Plume & Atwood Manufacturing Co., North Main St., Thomaston, Conn.

Gerin, Fernand L., president and technical director, The Gerin Corp., Avon, N. J.

Grabbe, Dmitry, engineer, Photocircuits Corp., 31 Sea Cliff Ave., Glen Cove, N. Y.

Halpin, James E., technician, Transit-Mix Concrete Corp., 136 E. Fifty-seventh St., New York 22, N. Y. For mail: 62 Winchester Dr., Manhasset, N. Y.

Kates, L. W., director of engineering, Sylvania-Corning Nuclear Corp., Hicksville, N. Y.

Kirkland, W. G., chief engineer, American Iron and Steel Inst., 150 E. Forty-second St., New York 17, N. Y.
Langton, W. M., technical director, Permatex Co., Inc., 300 Broadway, Huntington Station, N. Y. For mail: 15 Birchwood Dr., New Hyde Park, N. Y.
Mac Lean, A. G., Jr., vice-president, Rayflex Fabrics, Inc., 20 W. Thirty-seventh St., New York 18, N. Y.
Munisteri, Joseph G., Bechtel Corp., Box 1690, Grand Central Station, New York 17, N. Y. [A]
Muller, Alfred C., assistant division chemist, Consolidated Edison Company of New York, Inc., 4 Irving Pl., New York 3, N. Y. For mail: 149-27 Twentieth Ave., Whitestone 57, N. Y.
Shaines, Alfred, supervisor, Plastics Research, Research Div., American Radiator and Standard Sanitary Corp., 40 W. Fortieth St., New York 18, N. Y.
Strother, Robert G., manager, Eastern Region, Magnaflux Corp., 25 W. Forty-third St., New York 36, N. Y.
Voss, James W., assistant engineer, New Jersey Bell Telephone Co., 540 Broad St., Newark, N. J.
Ward, Joseph S., president, Joseph S. Ward, Inc., 91 Roseland Ave., Caldwell, N. J. For mail: Box 91, Caldwell, N. J.
Weed, Edwin A., partner, Schofield & Weed, 331 Madison Ave., New York 17, N. Y.

NORTHERN CALIFORNIA DISTRICT

Testing and Controls, Inc., William F. Jones, principal, 544 S. San Antonio Rd., Mountain View, Calif.
Estrada, Neil S., supervisor, Research and Development, Reichhold Chemicals, Inc., 120 S. Linden Ave., South San Francisco, Calif.
Kelly, Raymond D., superintendent, Technical Development, United Air Lines, Inc., San Francisco International Airport, San Francisco, Calif.
Kutnewsky, D., technical director, Burke Rubber Co., 2250 S. Tenth, San Jose, Calif.
Murphy, Raymond F., 650 El Camino Real, Redwood City, Calif.
Sullivan, F. R., plant metallurgist, Caterpillar Tractor Co., 800 Davis St., San Leandro, Calif.

OHIO VALLEY DISTRICT

Taylor Sons Co., Charles, The, Addison Maupin, assistant to president, Box 58, Annex, Station, Cincinnati 14, Ohio.
Behn, Frederick E., assistant engineer, Ohio Department of Highways, 450 E. Town St., Columbus 15, Ohio.
Crumbley, Cecil F., chief specification engineer, The International Nickel Co., Inc., Huntington, W. Va.
Green, Herbert L., vice-president and chief chemist, Brulin and Co., Inc., 2939 Columbia Ave., Indianapolis 7, Ind.
Jordan, Harold B., engineer in charge, Miscellaneous Section, Ohio State Highway Testing Laboratory, Ohio State University Campus, Columbus 10, Ohio.
Tragard, John O., manager, Contract Operations, Industrial Nucleonics Corp., 1205 Chesapeake Ave. Columbus 12, Ohio.

PHILADELPHIA DISTRICT

Princeton Research and Development Corp., Ellis S. Vieser, director, Runnemede, N. J.
Bawa, K. S., soils and foundation engineer, Gannett, Fleming, Corddry & Carpenter, Inc., 600 N. Second St., Harrisburg, Pa.
Berger, Jacob J., vice-president, Berger Associates, Inc., Hall Bldg., Second and Locust Sts., Harrisburg, Pa.
Cahan, Barton M., secretary-treasurer, Cahan Co., Inc., 141 N. Fifteenth St., Philadelphia 2, Pa. [A]
Chaplin, Frank S., associate director, The Franklin Inst., Philadelphia 3, Pa., For mail: Johnson Rd., Norristown, R. D. 4, Pa.
Craig, Frank C., Jr., president, United Testing Laboratory, S. Broad St., Box 101, Yardville, N. J. For mail: 42 E. Graisbury Ave., Audubon 6, N. J. [A]

Hunter, Leon E., assistant supervisor, Analytical Section, Socony Mobil Oil Co., Inc., Research and Development Lab., Paulsboro, N. J.

Kahl, E. Konrad, process and materials engineer, Raytheon Manufacturing Co., Maynard, Mass. For mail: Box 71, Chadds Ford, Pa.

Kardon, Donald R., executive secretary, American Bag and Paper Corp., Water and South Sts., Philadelphia 47, Pa. [A]

Koenig, Robert F., manager, Materials and Processes, Missile and Ordnance Systems Dept., General Electric Co., 3198 Chestnut St., Philadelphia 4, Pa.

Lewis, Charles R., textile project engineer, International Latex Corp., Playtex Park, Dover, Del. [A]

Mack, John J., chief engineer, Tidewater Oil Co., Delaware City, Del.

Morris, Albert G., senior research chemist, Foote Mineral Co., Berwyn, Pa.

Reider, M. J., president, M. J. Associates, 107 Angelica St., Reading, Pa.

Scott, Morton W., senior scientist, Smith, Kline & French Laboratories, 1500 Spring Garden St., Philadelphia 1, Pa. For mail: 4A Chew & Washington Lane, Philadelphia 33, Pa.

Thompson, Charles F., manager, Applications Engineering Dept., Nuclear Systems, Division of Budd Co., 2950 Roberts Ave., Philadelphia 32, Pa.

Tkac, Vincent J., supervisor, Control Laboratories, Tidewater Oil Co., Delaware Refinery, Delaware City, Del.

Williams, John Jr., technical director, United Gilsonite Laboratories, Jefferson Ave. and New York St., Scranton 1, Pa.

PITTSBURGH DISTRICT

Brennan, J. Norton, associate professor of engineering mechanics, The Pennsylvania State University, University Park, Pa. For mail: Box 696, State College, Pa.

Evans, Arthur W., resident engineer, Email, Ltd., (Australia), Box 565, East Pittsburgh, Pa.

Frazier, John Earl, president and secretary, Frazier-Simplex, Inc., 436 E. Beau St., Washington, Pa.

Lula, R. A., chief research metallurgist, Allegheny Ludlum Steel Corp., Brackenridge, Pa. For mail: 923 Oakwood Pl., Tarentum, Pa.

Mazza, Joseph S., group leader, Radiation Services, Pittsburgh Plate Glass Co., Glass Research Center, Box 11472, Pittsburgh 38, Pa. [A]

Oaks, Arthur E., engineer, Westinghouse Electric Corp., Bettis Field, Box 1468, Pittsburgh 30, Pa. For mail: 5645 Hobart St., Pittsburgh 17, Pa.

ROCKY MOUNTAIN DISTRICT

Fountain Sand and Gravel Co., Guy E. Clark, plant engineer, Joplin St. and Arkansas River, Box 535, Pueblo, Colo.

Robinson Brick and Tile Co., The, A. Curtis Jackson, vice-president—production, Box 1619, Denver, Colo.

Brandt, William O., director of research, Denver Fire Clay Co., Box 5510, Denver 17, Colo.

Wright, James R., engineer, City of Sheridan, Engine Ring Dept., Sheridan, Wyo.

ST. LOUIS DISTRICT

Bierman, Sidney, president and general manager, Precon Concrete Products Co., 1701 S. Hanley Rd., St. Louis 17, Mo.

Guhman, William H., public works director, St. Louis County, Department of Public Works, Court House, 7900 Forsyth, Clayton, 5, Mo.

SOUTHEAST DISTRICT

Aluminum Foils, Inc., W. J. Baenziger, executive vice-president, 1100 Richmond St., Jackson, Tenn.

Calcium Products Div., The Georgia Marble Co., Robert F. Hall, technical service director, Tate, Ga.

Columbia-National Corp., B. S. Albelda, production control supervisor, Box 1247, Pensacola, Fla.

Jackson Ready-Mix Concrete, Dale Cobb, vice-president, Marketing, Box 1292, Jackson 5, Miss.

Brown, Milton L., secretary, Mobile Textile Finishing Co., P. O. Drawer 269, Mobile, Ala. [A]

Hange, D. W., c/o Leroy Bishop, 143 Highland Ave, Holly Hill, Fla.

Palm Beach, County of, Board of County Commissioners, county engineer, Box 2429, W. Palm Beach, Fla.

Sellers, Henry G., Jr., assistant research director, ORRadio Industries, Inc., Shamrock Circle, Opelika, Ala.

Shatzen, M. L., Jr., Radiation Effects Dept., #75-25, Lockheed Aircraft Corp., Marietta, Ga. For mail: 6086 Kayron Dr., N. E., Atlanta 5, Ga.

Smawley, Earl C., Jr., president, Cummings & Smawley, Inc., Box 1242, Ft. Myers, Fla.

SOUTHERN CALIFORNIA DISTRICT

Battema, John P., laboratory director, Ferro-Spec Laboratories, Inc., 4112 S. Main St., Los Angeles 37, Calif. For mail: 2516 W. 150th St., Gardena, Calif.

Carlson, C. A., assistant manager, Sciaky Brothers, Inc., 2311 Purdue Ave., Los Angeles 64, Calif.

Steffen, Paul J., mechanical engineer, Landon, Inc., 7240 Fulton, North Hollywood, Calif. For mail: 3311 Adina Dr., Los Angles 28, Calif.

Vernon, City of, Engineering Dept., 4305 Santa Fe Ave., Vernon 58, Calif.

SOUTHWEST DISTRICT

French, John S., engineering supervisor, City of Beeville, Engineering Dept., Beeville, Tex.

Hadley, John P., chief chemist, El Paso Natural Gas Products Co., Box 3986, Odessa, Tex.

Lank, William J., chief engineer, Dallas Tank Co., Inc., Box 5387, Dallas 22, Tex.

Nelson, Gurney, Jr., assistant professor of civil engineering, Southern University, Southern Branch P. O., Baton Rouge, La. [A]

Orr, William G., Texas-U. S. Chemical Co., Box 1597, Port Neches, Tex.

Pfeiffer, C. E., plant manager, Gulf States Tube Corp., Box 952, Rosenberg, Tex.

Robertson, Roger, E., chief engineer, B & H Instrument Co., Inc., 3479 W. Vickery Blvd., Fort Worth 7, Tex.

WASHINGTON (D. C.) DISTRICT

Beiser, George, chief, Planning and Development Dept., American Research and Manufacturing Corp., 920 Halpine Ave., Rockville, Md.

Bixby, Howard M., field engineer, National Crushed Stone Assn., Inc., 1415 Elliot Pl., N. W. Washington 7, D. C.

Frisco, L. J., research contract director, Dielectrics Lab., The Johns Hopkins University, 1315 St. Paul St., Baltimore 2, Md.

Gerhold, William F., materials engineer, National Bureau of Standards, 105 N. W. Bldg., Washington 25, D. C.

Oliver, Kenneth R., Jr., research chemist, The Dow Chemical Co., Williamsburg, Va.

Shea, John E., deputy chief, Engineering Section, U. S. Department of the Air Force, National Guard Bureau, Installations Branch, Rm. 3D238, Pentagon, Washington 25, D. C. For mail: 6006 Grayson St. Springfield, Va.

WESTERN NEW YORK-ONTARIO DISTRICT

Allegheny Electronic Chemicals Co., Thayer Rudd, plant manager, Box 529, Bradford, Pa.

Anderson, W. J., assistant head design engineer, Linde Co., Division of Union Carbide Corp., East Park Dr. and Woodward Ave., Tonawanda, N. Y.

Haiblen, A. H. D., president, Jedwin of Canada, Ltd., 170 Bloor St., W., Toronto 5, Ont., Canada.

Kirchner, Henry B., principal ceramic engineer, Cornell Aeronautical Laboratories, Inc., 4455 Genessee St., Buffalo 21, N. Y.

Lazier, Morley J. C., professor of mechanical engineering, Waterloo College and Associate Faculties, Waterloo, Ont., Canada.

Palvio, T., chief chemist, St. Lawrence Cement Co., Box 520, Clarkson, Ont., Canada.

Piovaty, Peter I., product development manager, Harding Carpets, Ltd., Brantford, Ont., Canada.

Werner, Robert I., chief metallurgical engineer, R. D. Werner Co. (Canada), Ltd., 1155 Simcoe St., S. Oshawa, Ont., Canada. [A]

OUTSIDE ESTABLISHED DISTRICTS

National Appliance Co., Dan R. Reece, partner, 7634 S. W. Capitol Highway, Portland 19, Ore.

Ebmeyer, W. W., secretary-treasurer, Temp-Control Corp., 2905 N. Mississippi Ave., Portland 2, Ore.

McPherson, George H., director, Research and Development, Clarke-Halawa Rock Co., Box 1207, Honolulu, Hawaii.

Work, G. A., engineer, Fulton & Cramer, 922 Trust Bldg., Lincoln, Nebr.

OTHER THAN U. S. POSSESSIONS

Brown Boveri (Canada), Ltd., F. Schleuniger, chief engineer, Box 85, St. Johns, P. Q., Canada.

Bv-Aral Aktiengesellschaft, Th. Hammerich, manager, Wittenerstr. 45, Bochum, Germany.

Compania de Cemento Pacasmayo S. A., Jorge Grieve, director and adviser, Edificio Malaga Santolalla 144, Avenida Tacna 543, Lima, Peru.

Egyptian Copper Works, S. A. E., The, P. O. Bag, Alexandria, Egypt.

Fabrica Nacional de Vagoes S. A., Aureliano Albuquerque, general manager, Rua 24 de Maio, 250–14° Andar, Caixa Postal 4736, Sao Paulo, Brazil.

Productos de Cobre de Cuba PhelDrak, S. A., Rodolfo Alfonso, assistant technical director, 23 No. 55, Apto. 222, Vedado, Havana, Cuba.

Shaw and Co., Ltd., Francis, J. G. Mackay, managing director, Corbett St., Bradford, Manchester 11, England.

Western Engineering, J. Raymond Watson, secretary, 186 W. Mendez Vigo St., Mayaguez, Puerto Rico.

Ayers, F. E., director of planning and works, Corporation of the City of Ottawa, Transportation Bldg., 48 Rideau St., Ottawa, Ont., Canada.

Blackwood, A. L., chief chemist, Firestone Tyre and Rubber Co. of India, Ltd., Box 197, Bombay 1, India.

Brown, Arthur T., product control superintendent, Minnesota Mining and Manufacturing of Canada, Box 757, London, Ont., Canada.

Canadian Good Roads Assn., Library, 270 Maclaren St., Ottawa 4, Ont., Canada.

Craib, Charles Cole, group leader, Chemical Laboratory, Sherwin Williams Company of Canada, 2875 Centre St., Montreal 22, P. Q., Canada.

de Castro, Heriberto, vice-president and treasurer, Disenos y Construcciones C. por A., Hermanos Deligne 24, Ciudad Trujillo, Dominican Republic.

Gomez Lesseur, Gustavo, civil engineer, Apartado 10532, Caracas, Venezuela. [A]

Grosso, Mario, Via Cavour, 46, Torino, Italy.

Husain, Syed Abbas, chemist, Central Soil Mechanics and Hydraulics Laboratory, Ahmed Colony, Drigh Rd., Karachi 8, Pakistan.

Jeanhaut, J., president, Analis S. A., 14 Rue Dewez, Namur, Belgium.

Knox, William Burr, chartered civil engineer, The Cementation Co., Ltd., Box 2, Bentley Works, Doncaster, England.

Louis, Pierre J., manager, Institut Francais de L'Emballage et du Conditionnement, 3 Rue La Boetie, Paris 8^{e}, France.

MacHutchin, Graham J., secretary-treasurer, Diamond Flooring, Ltd., 8155 Durocher 57, Montreal 15, P. Q., Canada. [A]

McDonald, Albert, D., Pressure Pipe Co. of Canada, Ltd., 60 Vulcan St., Rexdale P. O., Ont., Canada.

Milgram, Abraham S., structural engineer, Orinoco Mining Co., Puerto Ordaz, Estado Bolivar, Venezuela. [A]

Moraldi, Georgio, civil engineer, Air Ministry, VIII Reparto Lavori, Ciampino, Rome, Italy. For mail: Viale Regina Margherita 101, Rome, Italy.

Nedorostek, Leopold J., technical director, Busch-Jaeger Durener Metallwerke AG, Ludenscheid, i. Westf., Werk Schafsbrucke, Western Germany. For mail: Schafsbrucke 10/11. Ludenscheid i. Westf., Western Germany.

Nomura, Shigeki, director, Kurashiki Rayon Co., Ltd., 2 Umeda, Kitaku, Osaka, Japan.

Salomon, T., head of laboratory, Institut Francais Du Petrole, 4, Pl., Bir-Hacheim, Rueil-Maimaison (S.O.), France.

Siddiqi, Anwar Husain, chemist, Central Soil Mechanics and Hydraulics Laboratories, Ahmed Colony, Drigh Rd., Karachi 8, Pakistan. For mail: B, Section 1/2, Lalukhet, Karachi 19, Pakistan. [A]

Trevelyan, B. J., director of research, Research Laboratories, Fraser Cos., Ltd., Edmundston, N. B., Canada.

Tropauer, Martin Laurence, materials engineer, Rader and Associates, 111 N. E. Second Ave., Miami, Fla. For mail: Rader and Associates, American Embassy, Vientiane, Laos.

NEWS NOTES ON
Laboratory Supplies and Testing Equipment

Note—This information is based on literature and statements from apparatus manufacturers and laboratory supply houses. The Society is not responsible for statements advanced in this publication.

LABORATORIES ITEMS

Rate Tester—Model 625B High Rate Tester consists of separate loading and recording sections for remote testing. It features essentially consistent deformation rates, continuously variable from 4 to 8000 in. per min.
Allegany Instrument Co., Inc. 1659

Pressure Tester—A new Bi-Fluid design in pressure testers has been introduced. New dead weight pressure tester, Type No. 472 is for use in the aircraft industry, missile components, etc.
Author Testing Instrument Co., Inc. 1660

Preamplifier—The preamplifier 620 makes available at the ultrasonic transducer output a tuning coil which will respond at all frequencies from 6–70 Mc with the fixed capacity of the crystals which may reach 100 μf in ultrasonic work.
Arenberg Ultrasonic Laboratory, Inc. 1661

Titration Base—A new polyethylene titration base, adaptable to all sizes of standard rings stands, has been developed. An important advantage of this new titration base is its portability, which allows it to be used in conjunction with any existing ring stand, and also provides for maximum ease of cleaning.
American Agile Corp. 1662

Insulating Oil Tester—A new high voltage tester, Model 4505 Hypot, for testing breakdown of all insulating liquids is announced. It is designed to test insulation liquids such as transformer oil to meet ASTM and Federal Specifications.
Associated Research, Inc. 1663

Scintillation Spectrometer—A new automatic Scintillation Spectrometer has been developed and is now available. An exclusive design, the B-A Spectrometer introduces a new concept in automatic data processing in the field of atomic instrumentation, providing automatic histogram-plotting of integral or differential spectra.
Baird-Atomic, Inc. 1664

75-Ton Compacting Press—A new 75-ton compacting press, which provides a new high in production speed and quality and eliminates powder loss, has been introduced. The press, Model 75-A, was designed for compacting such materials as powdered metals, abrasives carbides, cermets, ferrites, nuclear and other solid fuels for rockets and missiles.
Baldwin-Lima-Hamilton Corp. 1665

Transistor Preamplifiers—Developed for use with noise microphones, hydrophones, accelerometers, and other types of transducers. They provide high input and low output impedance in an amplifier with low noise level and excellent dynamic range.
Chesapeake Instrument Corp. 1666

Diffusion Pump—A rugged, all metal 2-in. Mercury Diffusion Pump with a higher limiting forepressure than many larger mercury pumps has been introduced.
Consolidated Electrodynamics Corp. 1667

Electronic Micrometer—A new model digital read-out automatic electronic Micometer features adjustable measuring pressure; standard reference measuring pressures can be set to 1.5, 5, 10, or 20 grams and with a special tip a negligible measuring pressure is available.
J. W. Dice Co. 1668

Arbor Press—Development of a new 7-lb Arbor Press for determining the caking characteristics of powdered materials has been announced. It can be utilized for both field and laboratory work and is also suited for checking springs, plastics, rubber, sockets, and similar items.
W. C. Dillon and Co., Inc. 1669

Infrared Detector—A new photo detector which is capable of responding to infrared wavelengths out to 5μ has been announced. Designated the Kodak Extron Detector (Lead Selenide), the photo detector responds out to 4.5μ at room temperature, with a time constant of less than 10 microseconds.
Eastman Kodak Co. 1670

Oscilloscope—A new professional 2-channel oscilloscope, known as Model K-260, is the fourth in a brand new line of laboratory oscilloscopes.
Electronic Tube Corp. 1671

DC Converter—A fully transistorized Frequency Converter has been introduced. The new unit, which converts a-c signals into either direct voltages or amplified pulse outputs, occupies less than half the space of conventional designs.
Fischer & Porter Co. 1672

Induction Carbon Apparatus—The apparatus burns the sample in a stream of pure oxygen, heating it with a radio-frequency induction coil. The whole process, from the time the analyst pushes the button, is carried out automatically in 2 minutes.
Fisher Scientific Co. 1673

Testing Concrete—Designed specifically for the routine testing of concrete and concrete products, the new Forney Model LT-700 conforms to all current ASTM and AASHO specifications.
Forney's, Inc. 1674

Film Comparator—The Coordinate Plate & Film Comparator is designed for coordinate measurements on plates and films, and is especially useful for ultracentrifuge and electrophoresis plates and films.
Gartner Scientific Corp. 1675

Transfer-Function Meter—The new type 1607-A Transfer-Function Meter can measure functions over the frequency range from 25 to about 1500 Mc, and can also measure any two-terminal impedance or admittance over the same range.
General Radio Co. 1676

Syphon—An all-polyethylene syphon with a built-in "self-starter" is now available. It consists of a semi-rigid "U" tube which has an open end and a flexible "squeeze" bulb attached to the other end.
General Scientific Equipment Co. 1677

Ultrasonic Cleaners—A new line of ultrasonic cleaners is being marketed. It includes six models of bench, floor, and self-contained styles, all featuring forced air-cooling and varying tank capacities according to need.
Gulton Industries, Inc. 1678

Paper Tester—The S-P-S Tester is now available with an automatic timing attachment and electric stop timer. It measures the smoothness, porosity and softness of paper and paperboard. The instrument was developed to test the printing quality of paper, and conforms to TAPPI suggested method T 479 – sm 48.
W. and L. E. Gurley 1679

Vacuum Gauge—A new type vacuum gauge for direct reading, recording, and control of absolute pressures in the hard-to-measure range of 0.1 to 20 mm of mercury has been announced.
Hastings-Raydist, Inc. 1680

Surface Grinder—A new Swedish hydraulic surface grinder is available in three sizes, 9 by 24 in., 10 by 29 in., and 12 by 39 in. The units feature adjustable precision roller bearings and spherical ball bearings, specially combined for controlling the thrust of the spindle.
Homstrand, Inc. 1681

Automatic Control—A new control device is now available for use by laboratory scientists. It consists of a compact unit which can be used with laboratory thermometers, manometers, and barometers and is able to sense the level of the mercury inside the glass tubing.
Instruments for Research and Industry 1682

Chromatographic Analyzer—A newly designed ultraviolet chromatographic analyzer enables petroleum analysts to determine aromatic, olefinic, and saturated hydrocarbons by the ASTM Fluorescent Indicator Adsorption Method.
Jarrell-Ash Co. 1683

Scintillation Transducer—Combining a high-clarity, thallium-activated, sodium-iodide crystal optically joined to a standard 2-in. photomultiplier tube, the Model NST2 Scintillation Transducer offers the combination of maximized pulse height and optimum resolution.
Levinthal Electronic Products, Inc. 1684

Square-Root Integrator—Designed to meet instrumented system needs of flow measurement, a new and compact square root integrator provides a continuous means of automatically totaling flow.
Librascope, Inc. 1685

Particle Testing—A completely re-engineered testing unit, the NQ-242, employs the wet magnetic particle inspection method—either visible or fluorescent—and provides a rapid means for production testing of small ferrous parts up to 24 in. long.
Magnaflux Corp. 1686

Glossmaster—New Model II Glossmaster, a universal instrument which measures gloss units of paints and similar material. The new instrument also permits gonio-photometric information to be obtained.
Manufacturers Engineering and Equipment Corp. 1687

Rubber Stretching Apparatus—The MDC Model 701-1 Dynamat will stretch rubber samples of the type used in rubber research tests and meets ASTM requirements. It can be used to determine the degree of rubber deterioration caused by ozone on constantly flexing rubber.
Mast Development Co., Inc. 1688

Temperature Sensor—A temperature Sensor specially designed to AIEE Standards for monitoring temperature of large rotating machinery and similar applications is a recent addition to the line of temperature sensing and monitoring devices.
Minco Products, Inc. 1689

Instrumentation Recorder—Remote electronic speed control, fully transistorized recording the playback modules, and a tape transport unit with dynamic braking make the new Model C-100 Instrumentation Tape Recorder completely versatile. No belts to change, and a total of 12 moving parts in the entire record-playback system insure reliability as well as ease of operation for the system, which handles from one to 14 tracks of simultaneous data.
Minnesota Mining and Manufacturing Co. 1690

Calibration—A new electronic calibration system that is completely transistorized and powered by six conventional flashlight batteries has been announced. Designed for the calibration of force measurement systems, it is accurate to 0.1 per cent.
Morehouse Machine Co. 1691

Microhardness Readings—A new microhardness tester that utilizes a virtual frictionless hydraulic method, loads a diamond indentor which supplies a direct reading corresponding to Vickers within fifteen seconds and eliminates a microscope. Specimen tables and conversion charts are being offered.
Newage Industries, Inc. 1692

Alpha Counter—A new instrument that covers any scaler into an alpha-counting system is announced. It is known as the Model SCC-11 alpha-scintillation counter converter.
Nuclear Measurements Corp. 1693

Radioactivity Monitor—A new low-cost, multi-purpose radioactivity monitor, which provides continuous visual and audible indications of radioactivity level for warning against hazards and for measurements in industrial, clinical, educational, and research applications, is now available.
Nucleonic Corporation of America 1694

Voltage Regulator—Now available is a highly regulated, stable, precision d-c Power Supply for laboratory or field use.
Owen Laboratories, Inc. 1695

Marking Stylus—Permanently marks glass, quartz, and ceramics. Combining a titanium marking stylus in a high-quality, anodized-aluminum holder, the Oxford Glascriber permits chemical and heat-resistant marking on all types of glass, quartz, and ceramic surfaces.
Oxford Laboratories 1696

Photometer—A New Recording Flow Photometer can be used with commercially available metering pumps and accessory equipment for the determination of amino acids and other amino compounds.
Phoenix Precision Instrument Co. 1697

Counters—Non-photosensitive, all-glass, halogen-quenched, geiger counters have transparent, patented, non-metallic conductive cathode surface. Thin glass walls permit high beta radiation transmission.
Radiation Counter Laboratories, Inc. 1698

Dry Circuit—New Hi-So relay combines a dry circuit and a 10 amp contact rating in a single enclosure.
Relay Sales 1699

Totalizer—A Multiplier-Totalizer unit is now being made. The multiplier circuit plugs into the drop counting unit of the Fraction Collector and permits counting either in the normal range of up to 400 drops per fraction or in a double range of up to 800 drops per fraction.
Research Specialties Co. 1700

Vacuum Furnace—A high temperature vacuum furnace for creep testing, complete with integral recording type extensometer is available for use with its creep testing and universal testing machines.
Riehle Testing Machines 1701

Metal-Surface Theromometer—Available in standard ranges of 0–450, 0–650, and 0–1000 F, the unit gives stable readings within one second, is completely self-contained, uses no batteries and has an easily read linear scale.
Royco Instruments, Inc. 1702

Recording Systems—A completely new series of 6- and 8-channel direct writing oscillographic recording systems provide greatly reduced size, improved performance, and greater reliability. The new "350" series are complete 6- or 8-channel systems packaged in a single mobile vertical cabinet.
Sanborn Co. 1703

Moisture Analysis—The new Schlumberger NMR high-speed moisture analyzer (Model 104) makes quantitative determinations of moisture content in solids, such as wood pulp, cotton, and cereals. Other products that can be effectively analyzed by the Model 104 are soap, polyethylene, geological cores, clay, and fibrinogen. It carries out this analysis in from 30 sec to four min, as opposed to the four hr required by the oven or similar conventional methods.
Schlumberger Well Surveying Corp. 1704

Electronic Counter—Tally-Count, new predetermining electronic counter, automatically controls any process involving high-speed counting.
Standard Instrument Corp. 1705

Strain Gage Carrier—Strain gage signal amplification to voltage levels suitable for direct use in telemetry has been developed. The new Models CA3 and CA5 Strain Gage Carrier Amplifiers operate from the typical airborne 28-volt d-c supply and provide an output of 0–5 v dc exactly proportional to the quantity being measured.
Statham Instruments, Inc. 1706

Tube Tester—A fully automatic air tester tests approximately 2100 specimens an hour with positive rejection of leaks.
Steel City Testing Machines, Inc. 1707

(*Continued on page 98*)

Laboratory Items

(*Continued from page 95*)

Combination Potentiometer—A new testing instrument, now in production combines all of the functions of a precision potentiometer, an accurate millivolt source and milliammeter.
Technique Associates, Inc. 1708

Ultra-Violet Lamp—For use in ASTM test D 1319 - 56 T, chromatography, and laboratory research.
Ultra-Violet Products, Inc. 1709

Transducer—A new, improved dual coil, variable reluctance pressure transducer for use with commercially available carrier systems and bridge circuits is introduced. Differential, gage, and absolute models are offered with numerous pressure ranges from 0–5 psi through 0–3000 psi and ±2 psi through ±300 psi.
Ultradyne, Inc. 1710

CATALOGS & LITERATURE

Electrometer Bulletin—A new 4-page bulletin describes the Cary Model 31 Vibrating Reed Electrometer. It is used to measure radioactivity, C^{14}, H^3, S^{35}, ion currents in mass spectrometers, pH, electrical properties and similar applications where very small currents, charges, and voltages must be measured.
Applied Physics Corp. 2428

Potential Tests—New bulletin (5-1.2) details full specifications and specific application data of some 15 d-c Hypot models covering output ranges of 5, 10, 20, and 30 kv dc.
Associated Research, Inc. 2429

Repeat Cycle—A new 4-page bulletin, *No. N-80*, describing the ATC Miniature Atcotrol "Duo-Set" repeat cycle dial timer which controls two independently adjusted load circuits for ON-OFF cycling is now available.
Automatic Timing and Controls, Inc. 2430

Oxygen Analyzer—*Bulletin 0-4114* describes Model 80 Oxygen Trace Analyzer, a dual range instrument which continuously measures gas samples for minute quantities of oxygen, as low as 0–5 ppm.
Beckman/Process Instruments Division 2431

Plastic Ware—*Catalog 658*, containing 24 pages, gives complete line of plastic laboratory ware.
Bel-Art Products 2432

Just Completed—New, 200-page *Catalog 158* illustrates and describes a complete line of electric ovens, furnaces, baths, environmental cabinets, related temperature control equipment and accessories for laboratory, pilot plant, and production.
Blue M Electric Co. 2433

Nuclear Lagoratory—Three new nuclear instrumentation bulletins technically describing Detectolab products are available. Model DZ15 Single-Channel Pulse Height Analyzer and Model DZ4 Fast-Slow Coincidence Circuit bulletins contain instrument descriptions, application information, and performance specifications.
Borg-Warner Corp. 2434

Environmental Testing—A new brochure describing and illustrating the facilities of environmental testing has been published.
Bowser-Morner Testing Laboratories Inc. 2435

Catalog—A new 12-page catalog of laboratory centrifuges is available.
Chicago Surgical and Electrical Co. 2436

Timing Instruments—A new catalog, *No. 258*, illustrating nearly 50 different models of stopwatches, chronographs, holders, timer boards and other timing instruments for use in industry and research has been issued.
M. Ducommun Co. 2437

Thermistor Catalog—Fifteen different thermistor circuits are described in a 16-page catalog, *EMC-2*. It also gives specifications for nearly 400 different thermistors including assemblies, matched pairs, beads, disks, washers, rods, and probes.
Fenwal Electronics, Inc. 2438

Glass Catalog—New 20-page catalog features expanded line of Lab-Crest laboratory glassware with leak-proof, freeze-proof, Lab-Crest stopcocks that require no grease.
Fischer & Porter Co. 2439

Counters—Development of the new 2020 Multiple Preset Counters for counting and control applications has been announced. These preset counters (described in bulletin) can be supplied with multiple groups of presetting controls for use in all vital industrial operations for accurate, high speed sequential predetermining counting and control.
Freed Transformer Co., Inc. 2440

Viscometer—*Bulletin 201-58* for the viscometer, now available, which has been adopted as the starch industry's standard instrument. The instrument is currently being used in both dry and wet milling industries, brewing, pulp and paper, and confectionery industries. It is also applicable to textiles, leather tanning, food and chemical processing.
Gaertner Scientific Corp. 2441

Catalog—Various laboratory equipment is described in *Catalog #15*.
Harshaw Chemical Co. 2442

Microwave—Bulletins describe new microwave oscillators (series 814) and use in spectroscopy. Nine pages give full details.
Laboratory for Electronics, Inc 2443

Borescopes—How more rapid internal visual inspection of blind rivets, parts, chambers, tubes, pipe, etc. can be accomplished through precision-made borescopes ranging in size from a few inches to more than 60 ft in length is illustrated and described in a two-color folder.
Lenox Instrument Co. 2444

Ring Dynamometers—The construction, application, and operation of ring dynamometers are discussed in a new *Bulletin #160*. The four-page, two-color bulletin describes in detail the accuracy of the ring dynamometer as a force measuring instrument.
Morehouse Machine Co. 2445

Radioactivity Absorber—A packaged set of radioactivity abosrbers, consisting of 24 lead and aluminum disks, is described in a new specification sheet.
Nuclear-Chicago Corp. 2446

Annunciator—*Bulletin 102* describes and illustrates new Model RA recording annunciator which accurately records temperature, pressure, flow, and levels.
Panellit, Inc. 2447

(*Continued on page 101*)

Federal Government Standards Changes

The General Services Administration of the Federal Supply Service is charged with the responsibility for establishing specifications to be used by the Federal Government for procurement of materials and supplies. The OSA issues an annual Index of Initiation of Federal Specifications Projects, and monthly supplements.

The items listed below appeared in Supplements Nos. 3 and 4, for the months of May and June, 1958.

INITIATIONS

Title	Type of Action	Symbol or Number	FSC Code	FSSC Class	Assigned Agency & Preparing Activity
Aluminum Alloy Plate and Sheet, Alclad 7075	Am. 1	QQ-A-287a	9535	..	DOD-Navy-Aer
Artificial Leather, Upholstery (synthetic resin coated cloth)	New	CCC-A-00700a (GSA-FSS)	8305	83	GSA-FSS
Asphalt, Cut-Back (for) Road Work	Am. 1	SS-A-671a	5610	..	DOD-Army-CE
Boxes, Paper Overlaid Veneer, Wood Cleated	New	PPP-B-576	8115	..	DOD-Army-QMC
Butyl Acetate, Normal (for use in organic coatings)	Rev.	TT-B-838a	8010	52	DOD-Navy-Aer
Carpet and Rug, Wool, Loop Pile, Knitted	New Rev.	DDD-C-80a & DDD-C-0080	8305	83	GSA-FSS
Cloth, Cotton, Sheeting (laundry cover cloth)	Int. Am. 1	CCC-C-435	8305	..	GSA-FSS
Cloth, Nylon, and Nylon & Wool (Bunting for flags)	Rev.	CCC-C-476a	8305	83	DOD Army-QMC
Continuous Identication Marking of Iron and Steel Products	New	Int. Fed. Std. 00133(GSA-FSS)	..	..	GSA-FSS
Detergent, Synthetic, Heavy Duty Powdered and Liquid	New	P-D-255	7930	51	PO
Drier; Paint, Liquid	Am. 1	TT-D-651c	8010	52	GSA-FSS
Enamel, Interior, Tints and White Gloss, Odorless	New New	TT-E-505a TT-E-509a	8010 8010	52 52	DOD-Army-CE DOD-Army-CE
Enamel, interior, Tints, White, Odorless	New	TT-E-00509 (Army-CE)			
Enamel Undercoat, Interior, Tints and White, Odorless	New New	TT-E-545a & TT-E-00545 (Army-CE)	8010	52	DOD-Army-CE
Film, Photographic and Film, Photo. Processed; (for permanent use)	Rev.	Fed. Std. No. 125a	6750	18	GSA-FSS
Isobutyl Acetate (for use in organic coatings)	New	TT-I-710	8010	52	DOD-Navy-Aer
Isobutyl Alcohol (for use in organic coatings)	New	TT-I-730	8010	52	DOD-Navy-Aer
Isopropyl Alcohol (for organic coatings)	New	TT-I-735	8010	52	DOD-Navy-Aer
Methanol (Methyl Alcohol)	Rev.	O-M-232b	6810	..	DOD-Army-CmlC
Paint, Acrylic Emulsion Exterior	Rev.	TT-P-0019a (Army-CE)	8010	52	DOD-Army-CE
Paint, Odorless, Alkyd Interior Flat White and Tints	Rev. New	TT-P-30b & TT-P-003a (Army-CE)	8010	52	DOD-Army-CE
Paint, Poly(Vinyl Acetate) Emulsion Exterior	Rev.	TT-P-0055a (Army-CE)	8010	52	DOD-Army-CE
Paint, Styrene-Butadiene Emulsion, Exterior	Rev.	TT-P-0099a (Army-CE)	8010	52	DOD-Army-CE
Pipe and Fittings, Bituminized-Fiber, Perforated Drainings	New	SS-P-00358 (COM-PR)	..	..	COM-PR
Plastic Rod, Solid, Poly (Vinyl Chloride), Rigid	New	L-P-503	9330	51	DOD-Army-Ord.
Plastic Tubing, Heavy Walled, Poly(Vinyl) Chloride), Rigid	New	L-P-540	9330	51	
Rags, Wiping, Cotton	Am. 1	DDD-R-30	7920	79	GSA-FSS
Sieves, Standard for Testing Purposes	Am. 1	RR-S-366b	6635	..	GSA-FSS
Tape, Pressure-Sensitive, Adhesive (cellophane, and cellulose actate)	Am. 1	L-T-0090b (GSA-FSS)	..	..	GSA-FSS
Water Repellent Compound Textile Finish	New	TT-W-156	..	..	DOD-Army-QMC
Wire, Electrical & Cable, Power, Electrical; Asbestos- and Asbestos-Varnished-Cloth; Insulated	New	J-W-00850 (GSA-FSS)	6145	17	GSA-FSS

PROMULGATIONS

Title	Type of Action	Symbol or Number
Aluminum Alloy, Plate and Sheet 2024 (superseding QQ-A-355b)	Rev.	QQ-A-355c
Cloth, Cotton, Osnaburg (superseding CCC-O-721)	New	CCC-C-429
Crates, Wood, Household Goods (superseding PPP-B-00580 (Army-CE)	New	PPP-C-580
Duplicating Fluid, Direct Process (spirit-type) (superseding O-D-825)	Rev.	O-D-825a
Fabric, Nonwoven	Am. 1	CCC-F-46
Film, Photographic and Film, Photographic, Processed; (for permanent record use)	New	Fed. Std. No. 125a
Insulation Blanket, Thermal-Acoustical, and Insulation, Thermal; Vegetable or Wood Fiber	Am. 1	HH-I-515
Linseed Oil, Heat Polymerized (superseding TT-O-367)	New	TT-L-201
Lubricants, Liquid Fuels, and Related Products; Methods of Testing	..	Fed. Test Method Std. 791 (Chg. Not. 3)
Porcelain Enamel Products & Major Household Appliances—Test Requirements for Packing of (superseding PPP-P-0021 (Navy-S&A)	News	PPP-P-600
Soap, Toilet (cake, milled) (superseding P-S-00621d (GSA-FSS) & P-S-621c)	Rev.	P-S-621e
Sodium Hydroxide, Technical, for cleaning Purposes	Am. 1	P-S-631b
Tape; Pressure Sensitive Adhesive, Waterproof—for Packaging and Sealing	Am. 2	PPP-T-60

INTERIM FEDERAL SPECIFICATIONS ISSUED

Title	Type of Action	Symbol or Number
Artificial Leather, Upholstery (synthetic resin coated cloth)	New	CCC-A-00700a (GSA-FSS)
Continuous Identification Marking of Iron and Steel Products	New	Std. 00133 (GSA-FSS)
Fencing (barbed wire, woven wire, and wire netting)	Am. 2	RR-F-221b
Lath, Gypsum	New	SS-L-0030 (GSA-FSS)
Paint; Traffic, Reflectorized	New	TT-P-0087 (Navy-Aer)
Pipe and Fittings, Bituminized-Fiber, Perforated Drainings	New	SS-P-00358 (COM-BPR)
Rags, Wiping, Cotton	Am. 1	DDD-R-30 (GSA-FSS
Roof Coating: Asphalt, Brushing-Consistency	New	SS-R-00451a (GSA-FSS
Sealing Compound, Two-Components, Jet-Fuel-Resistant, Cold-Applied, Concrete Paving	New	SS-S-00170a (Army-CE)
Sheathing Board: Gypsum	Am. 2	SS-S-276 (GSA-FSS)
Tape, Pressure-Sensitive, Adhesive (cellophane and cellulose acetate)	Am. 1	L-T-0090b (GSA-FSS)
Wire, Electrical and Cable, Power, Electrical; Asbestos Varnished-Cloth; Insulated	New	J-W-00850 (GSA-FSS)
Zinc Alloy Sheets and Strips	New	QQ-Z-00100 (GSA-FSS)

SPECIFICATIONS AND STANDARDS APPROVED FOR PRINTING

Title	Type of Action	Symbol or Number
Anodes, Copper	New	QQ-A-673
Asphalt; Cut-Back (for) Road-Work	Am. 1	SS-A-671a
Broadcloth; Cotton, Mercerized	Canc.	CCC-B-686a
Bronze, Aluminum; Bars, Plates, Rods, Shapes, and Strips	Canc.	QQ-B-666
Cloth, Cotton, Broadcloth, Mercerized	New	CCC-C-437a
Cloth, Cotton, Osnaburg	New	CCC-C-429
Conservation of Automotive Engine Oils	New	Fed. Std. No. 103a
Copper: Anodes	Canc.	QQ-C-493
Drums, Fiber	New	PPP-D-723c
Drums, Fiber, with Recessed Ends	New	PPP-D-715
Drums, Metal, Reconditioned 55-Gallon (for shipment of noncorrosive material)	New	PPP-D-723a
Fabric Nonwoven	Am. 1	CCC-F-46
Ink, Stencil, Duplicating Machine, Black, (for use on single-cylinder, internally inked, stencil-duplicating machines)	New	TT-I-564a
Ink; Stencil, Duplicating-Machine, Climateproof, Black, Castor-Oil-Base	Canc.	TT-I-557
Ink; Stencil, Duplicating-Machine, Climateproof, Black Non-Castor-Oil-Base	Canc.	TT-I-561
Insulation Blanket, Thermal-Acoustical, and Insulation, Thermal; Vegetable or Wood Fiber	Am. 1	HH-I-515
Linseed Oil, Heat Polymerized	New	TT-L-201
Lubricants, Liquid Fuels, and Related Products; Methods of Testing	New	Fed. Test Method Std. No. 791
Oil; Linseed, Heat-Polymerized (bodied), for Paint, Varnish, and Enamel	Canc.	TT-O-367
Osnaburg; Cotton	Canc.	CCC-O-721
Paint, Varnish, Lacquer, and Related Materials; Methods of Inspection, Sampling, and Testing	New	Fed. Test Method Std. No. 141
Porcelain Enamel Products and Major Household Appliances—Test Requirements for Packing of	New	PPP-P-600
Sieves, Standard For Testing Purposes	Am. 1	RR-S-366b
Soap, Toilet (cake, milled)	New	P-S-621ne
Standard Guides for Preparation of Item Identifications by Government Suppliers	Rev.	Fed. Std. No. 5a
Thread, Cotton	Am. 1	V-T-276d
Thread, Cotton Gimp, Buttonhole	New	V-T-280
Tubes, Copper, Seamless, 6000 p.s.i. Maximum Pressure	Rev.	WW-T-797a
Zinc; Sheet and Strip	Am. 1	QQ-Z-301b

Catalogs and Literature

(*Continued from page 98*)

Instrumentation Systems—A new 12-page, 1958 catalog digest including instruments, complete instrumentation systems, improved features, and brief informative descriptions of more than 50 instruments has been issued.
Panoramic Radio Products, Inc. 2448

Flash Point—A recently completed 4-page bulletin on the new time saving automatic Flash Point Tester, duplicating ASTM D 56 results and needing no attendance during test, is now available.
Precision Scientific Co. 2449

Apparatus Catalog—A new 32-page catalog, Vol. 10, No. 2 fully describes laboratory apparatus.
E. H. Sargent and Co. 2450

Spectrographic Materials—Catalog describes spectrographic supplies and accessories.
Spex Industries, Inc. 2451

Diode Tester—A new technical bulletin describing the Model 1001 Dynamic Diode Tester, an instrument for rapid and accurate testing of semiconductor diodes, has been published.
Technitrol Engineering Co. 2452

Miniature Thermocouples—A 28-page catalog describing a complete line of miniature thermocouples is now available.
Thermo Electric Co., Inc. 2453

Remote Control Catalog—An 8-page catalog describes the operation and construction of Crown Hydra-Trol Remote Controls together with typical applications in the industrial, marine, research, and military fields.
Trimount Instrument Co. 2454

Ultrasonic Testing—Catalog and data sheets describe ultrasonic testing equipment including Reference Blocks for ASTM Recommended Practice E 127 – 58 T.
Ultrasonic Testing and Research Laboratory 2455

Spectrophotometry—A 6-page brochure, *Lab-Guide No. 2*, graphically shows in chart form all the accessories, sample compartments, and component parts of the Beckman Model DU Spectrophotometer—and shows their relationship to the basic instrument and to each other.
Will Corporation 2456

NEWS OF LABORATORIES

Container Laboratories, Inc., Washington, D. C.—Expansion and relocation of the Washington Division of Container Laboratories, Inc., have been announced by Thomas P. Wharton, company vice-president and division manager. On August 15 the facilities of the Washington Division moved to new and larger quarters located at 6210 Kansas Avenue, Washington 11, D. C.

Harris Laboratories, Inc., Lincoln, Neb.—Has purchased the Lexington Laboratories, Lexington, Neb., one of the largest independent soil, feed, and agricultural laboratories in the midwest, and will continue to operate it at Lexington. Paul E. Nickel, well known soil scientist and chemist, will continue to act as general manager. Plans are developing to expand the facilities and services for the agricultural industry.

New York Testing Laboratories, New York, N. Y.—Has announced the expansion of its X-Ray Testing Department by the acquisition of new portable equipment and the development of new radiographic techniques. The portable equipment used by New York Testing Laboratories is equipped with a lead filter so that the area of radiation is confined to a specific target to minimize radiation hazards in the surrounding area.

INSTRUMENT COMPANY NEWS

Leitz, Inc., New York, N. Y.—American distributors of the Leica photographic line and Leitz scientific instruments, announced that it has assumed exclusive distribution of precision optical and mechanical instruments manufactured by Schmidt and Haensch, West Berlin. Under the new arrangement Leitz expects to achieve more thorough national distribution in the United States. Leitz has its own personnel in principal cities, as well as facilities and technicians in its own workshop, to service Schmidt and Haensch instruments.

Unitron Instrument Division of United Scientific Co., Boston, Mass.—Has the pleasure of announcing that Mr. John E. O'Hern, Quality Control Manager, American Cyanamid Co., Danbury, Conn. is the winner of the drawing for a Unitron Model MSA Auto-Illumination Microscope. This instrument was offered to all who registered at the Unitron booth located on the stage of the Hotel Statler (Boston) during the 61st Annual Meeting of ASTM.

OTS Reports

(*Continued from page 76*)

Powder Metallurgy. Catalog of Technical Reports. CTR-343, 10 cents.
Semi-Conductors. Catalog of Technical Reports. CTR-340, 10 cents.
Unconventional Power Sources, Part 1. Workman-Reynolds effect, emission, pyroelectricity, thermo-magnetic generators, electrostatics, piezoelectricity, and magnetostriction. PB 131411, $2.
Unconventional Power Sources, Part 2. Oscillating electromagnetic generator, thermopile generator, ion exchange membrane, fuel cell, and photovoltaic battery. PB 131218, $2.
Cold-Cured Piezoelectric Ceramics. PB 131523, 50 cents.
Development and Evaluation of Insulating-Type Ceramic Coatings: Part 1—Development and Small-Scale Testing. PB 131752, $2.50.
A Study of Graded Cermet Components for High-Temperature Turbine Applications. PB 131434, $1.25.
The Strength of Glass. PB 131532, 75 cents.
The Measurement of Insulation Conductivity. PB 131420, 75 cents.
Measurement of Thermal Diffusivity of Various Materials by Means of the High Intensity Electric Arc Technique. PB 131601, $1.75.
Interferometric Measurement of the Infrared Dispersion of Liquids. PB 131522, 75 cents.
A Comparison of Silicon and Germanium Low-Power Audio Alloy Transistors. PB 131364, 75 cents.
Performing Research on New Approaches to Printing Circuitry. PB 131366, $1.
Saturated Salt Humidity Test Equipment for Printed Circuit Material Evaluations. PB 131504, 75 cents.
Reliability Stress Analysis for Electronic Equipment. PB 131678, $3.

OTS Reports

Improvements in the Vibrating Condenser Method of Measuring Contact Potential Differences. PB 131530, 50 cents.

High Temperature Resistant Sealant Materials. PB 131478, 75 cents.

Design Data for O-Rings and Similar Elastic Seals. PB 131510, $3.

Synthesis and Characterization of New Vinyl Polymers. PB 131699, 75 cents.

Expansion Characteristics of Marlex 20 and Marlex 50. PB 131402, 75 cents.

Measurements of the Thermal Properties of Various Aircraft Structural Materials. PB 131432, $2.

The Chemical Reactions of Silicon Isocyanates. PB 131621, 50 cents.

Silicon-Oxygen-Tin Polymers. PB 131620, 75 cents.

Polymerization Studies on Monomers and Evaluation of Derivative Polymers. PB 131594, $3.

The Development of a Non-Adhering Chemically Foamed-In-Place Polyurethane Cushioning Material for Packaging Purposes. PB 131665, 75 cents.

Evaluation of Container-Grade Paper-Overlaid Veneer Panel Boxes for Overseas Use. PB 131553, $1.

Development of a Universal Method for Grease Analysis. PB 131354, 50 cents. A centrifuge technique was developed for fast, easy determination of the thickener and fluid components of most greases. The test can be used for greases with or without soap thickener and those containing either mineral or synthetic fluids. The method is said to be applicable to greases which are difficult or impossible to analyze by the conventional ASTM Method D 128 - 47. In analyses of greases adaptable to both methods, the new one takes about half the time necessary for the ASTM test.

Lubrication of Titanium. PB 131650, $1.50

Research on Liquid Metals as Power Transmission Fluids. PB 131743, $2.50.

Accelerated Storage Stability of Aviation Fuels. PB 131369, $1.

Bibliography of Fuel Stability, 1929–1957. PB 131482, $5.

Basic Factors in the Formation and Stability of Non-Soap Lubricating Greases: Part 3. PB 131233, $1.50.

Theoretical and Experimental Studies of Liquid Viscosity. PB 131403, $1.

High-Temperature Wear Evaluation Techniques and Data. PB 131410, 75 cents.

The Use of the Conoscope for the Inspection of Hot-Stretched Aircraft Glazing Materials. PB 131174, $1.

Mechanism and Kinetics of the Reaction Between Fuming Nitric Acid and/or its Decomposition Products and Gaseous Hydrocarbons. Liquid rocket oxidizers. PB 131415, $1.75.

Measurement of Detonation Induction Distances in Hydrogen-Oxygen and Acetylene-Oxygen-Nitrogen Mixtures at Normal and Elevated Initial Pressures and Temperatures. PB 131569, $2.50.

Design Data on Biaxial Forces Developed in Parachute Fabrics. PB 131658, $2.25.

OTHER SOCIETIES' EVENTS

September 29–October 1—**Technical Association of the Pulp and Paper Industry,** 9th Testing Conference, General Oglethorpe Hotel, Savannah, Ga.

October 5–8—**Federation of Paint and Varnish Production Clubs,** 36th Annual Meeting and 23rd Paint Industries' Show, Hotel Cleveland, Cleveland, Ohio.

October 5–8—**Society of Petroleum Engineers of AIME,** Fall Meeting, Houston, Tex.

October 8–10—**Gray Iron Founders' Society,** Annual Meeting, Sheraton Park Hotel, Washington, D. C.

October 13–15—**American Gas Assn.** Annual Convention, Atlantic City, N. J.

October 13–15—**Association of Official Agricultural Chemists,** Annual Meeting, Shoreham Hotel, Washington, D. C.

October 13–15—**American Society of Mechanical Engineers, American Society of Lubrication Engineers;** Joint Lubrication Conference, Hotel Statler, Los Angeles, Calif.

October 13–15—**National Electronics Conference, Inc.,** Hotel Sherman, Chicago, Ill.

October 13–17—**American Society of Civil Engineers,** Annual Convention, Statler Hotel, New York, N. Y.

October 14–16—**Society of Industrial Packaging and Materials Handling Engineers;** 13th Annual Packaging, Handling, and Shipping Show, Chicago Coliseum.

October 20–21—**American Coke and Coal Chemical Institute,** Annual Meeting, The Greenbrier, White Sulphur Springs, W. Va.

October 22–24—**American Ceramic Society,** 11th Pacific Coast Regional Meeting, Ambassador Hotel, Los Angeles, Calif.

October 23–25—**National Society of Professional Engineers,** Fall Meeting, St. Francis Hotel, San Francisco, Calif.

October 26–31—**American Institute of Electrical Engineers,** Fall General Meeting, Penn-Sheraton Hotel, Pittsburgh, Pa.

October 27–30—**The Metallurgical Society of AIME,** Fall Meeting, Carter Hotel, Cleveland, Ohio.

October 27–31—**American Society for Metals,** National Metal Congress and Exposition, Cleveland Public Auditorium, Cleveland, Ohio.

October 28—**Association of Consulting Chemists and Chemical Engineers,** Annual Meeting, Biltmore Hotel, New York, N. Y.

October 29–31—**National Agricultural Chemicals Assn.,** 25th Annual Meeting, Bon Air Hotel, Augusta, Ga.

October 30–31—**International Symposium on Plastics Testing and Standardization,** Benjamin Franklin Hotel, Philadelphia, Pa. (Sponsored by ASTM on behalf of the American Group for the International Organization for Standardization (ISO) Technical Committee 61 on Plastics.)

October 30–November 1—**American Association of Textile Chemists and Colorists,** Conrad Hilton Hotel, Chicago, Ill.

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